Orbit

Journal of the Radio Amateur Space Program

No. 15

September/October 1983

$2.00 U.S.A./Canada

ANNEE MONDIALE DES COMMUNICATIONS

WORLD COMMUNICATIONS YEAR

AÑO MUNDIAL DE LAS COMUNICACIONES

1983

Published by AMSAT — The Radio Amateur Satellite Corporation

Star Performers!

ICOM's VHF/UHF Pairs for Satellite Communications

Oscar 10...Are you ready? Join the future of amateur satellite communications with ICOM VHF and UHF transceivers. Read why ICOM is ...*Simply the Best* for satellite communications.

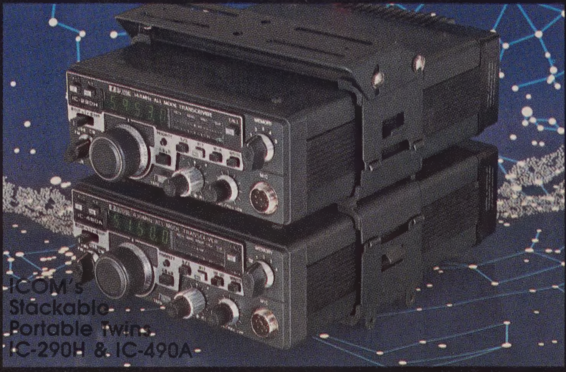
IC-271A/471A Twins

This new series of VHF/UHF base stations offers a combination of features and flexibility found in no other transceivers anywhere. For receiving MODE J down-link, the IC-471A features a less than 0.5 microvolt for 10dB quieting SSB receiver plus an optional mast mounted GaAs FET preamplifier with a 15dB gain.

Thirty-two tunable memories keep the IC-471A ready to go on frequency and to monitor the beacon frequencies. A good noise blanker plus all-mode squelch make listening a real pleasure. 10Hz variable speed tuning, which automatically shifts to 100Hz when needed, and a low-noise PLL that locks to 10Hz makes the frequency resolution of the ICOM Twins second to none. For MODE B use, the IC-471A features a 10W SSB transmitter with variable power control.

The same basic features of the IC-471A apply to the IC-271A and an optional internal preamplifier with front panel switch is available. The IC-271A transmitter features 25W of transmitter power.

The IC-471A and the IC-271A both have options for computer interfacing. The ICOM BUS is brought out through an optional interface to the back of the radio. From this point, it may be routed to the ICOM computer interface terminal, mounted in a matching box, that will convert the ICOM BUS to RS232C standard. Allowing computer control of both transceiver units, this capability, plus the antenna-tracking programs available for Oscar 10, will make the IC-271A and 471A Twins the ultimate for computer control of your satellite operations.


ICOM's Stackable Portable Twins IC-290H & IC-490A

IC-290H/IC-490A Twins

ICOM's IC-290H and IC-490A mount together as a stackable, mountable pair that offers versatility, portability and satellite capability in an incredibly small size. These units are easily hung from your ham shack bench, taken on portable operations or used mobile.

Each features multiple tuning rates, memories, FM/SSB/CW, programmable scan and priority function, and an all-mode squelch. The IC-290H has a 25W transmitter, the IC-490A, 10W. Both of these transceivers are high quality designs by ICOM and offer all the flexibility needed for satellite operations.

IC-271A VHF Multimode
2 Meter / 25 Watts

IC-471A UHF Multimode
430 — 450 MHz / 10 Watts

ICOM
The World System

ICOM America, Inc., 2112-116th Ave NE, Bellevue, WA 98004 **(206)454-8155** / 3331 Towerwood Drive, Suite 307, Dallas, TX 75234 **(214)620-2780**

All stated specifications are approximate and subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions.

MIRAGE

American made RF Amplifiers and Watt/SWR Meters of exceptional value and performance.

•5 year warranty • prompt U.S. service and assistance

RF AMPLIFIERS

2 METERS-ALL MODE

B23 2W in=30W out $89.95
(useable in: 100 mW-5W)

B108 10W in=80W out $179.95
(1W=15W, 2W=30W) RX preamp

B1016 10W in=160W out $279.95
(1W=35W, 2W=90W) RX preamp

B3016 30W in=160W out $239.95
(useable in: 15-45W) RX preamp
(10W=100W)

220 MHz ALL MODE

C106 10W in=60W out $199.95
(1W=15W, 2W=30W) RX preamp

C1012 10W in=120W out $289.95
(2W=45W, 5W=90W) RX preamp

C22 2W in=20W out $89.95
(useable in: 200mW-5W)

RC-1 AMPLIFIER
REMOTE CONTROL $24.95
Duplicates all switches, 18' cable

WATT/SWR METERS

- peak or average reading
- direct SWR reading

MP-1 (HF) 1.8-30 MHz
MP-2 (VHF) 50-200 MHz
$119.95

430-450 MHz ALL MODE

D24 2W in=40W out $199.95
(1W=25W)

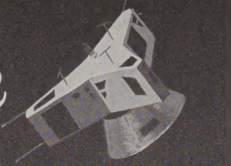
D1010 10W in=100W out
(1W=25W, 2W=50W) $319.95

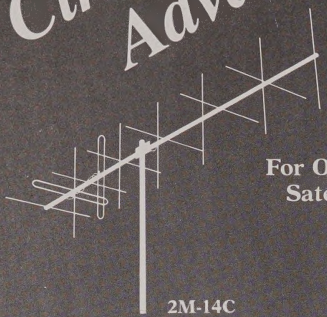
Available at local dealers throughout the world.

MIRAGE
COMMUNICATIONS EQUIPMENT, INC.

P.O. Box 1393, Gilroy, CA 95020 (408) 847-1857

The Circular Advantage





For OSCAR 10 and Russian Satellite Communications

KLM's Circular Polarized antennas have been specifically designed to optimize OSCAR 10 and Russian satellite operation. Quality workmanship and superior design, yield virtually perfect circular patterns over the satellite operational bandwidth. Enjoy less Multi-Path Distortion, less Flutter, Fade, and better S/N Ratios, with comparable performance on transmit.

Both the 2M-14C and 435-18C sport virtually unbreakable 3/16″ rod parasitic elements anchored thru the boom, folded dipole driven elements produce excellent physical and electrical symmetry for years of constant performance.

Specifications: (2M-14C)

BANDWIDTH:	144–150 MHz	BOOM LENGTH:	12′9″
GAIN:	11 dBdc	VSWR:	1.2:1
BEAMWIDTH:	48°	WINDLOAD:	1.25 sq. ft.
FEED IMP:	50 ohm unbal.	WT. (LBS):	7.5
BALUN:	4:1,2KW	ELLIPTICITY:	±3 dB Max.
CIRCULARITY SWITCHER:	INCLUDED		

The 435-18C is a star performer, an optional CS-2 circularity switcher puts left, and right-hand circular control in your shack, and doubles as a two port divider/impedance transformer for single feed line convenience.

Specifications: (435-18C)

BANDWIDTH:	420–450 MHz	GAIN:	12 dBdc
BOOM LENGTH:	7.3 ft.	VSWR:	1.5:1
BEAMWIDTH:	44°	FEED IMP:	50 ohm unbal.
WT. (LBS):	4.5	BALUN:	2–4:1. 1KW
MAST DIA:	Cen–Rear/1½″	ELLIPTICITY:	3dB MAX.
CIRCULARITY SWITCHER	(CS-2) OPTIONAL		

See your local KLM dealer or write for our complete catalog

KLM *electronics Inc.*
P.O. Box 816, Morgan Hill, CA 95037

Order All Ham Radios & Accessories from C-COMM

We have the
Products, Prices, and Service
that bring you back!

ICOM

IC-451A

The perfect high performance UHF transceiver for satellite use. 10 watt transmitter, 10 Hz tuning, mast mounted preamp available, scanning. Use for mode B uplink and mode J downlink. Incomparable performance at an unbelievable price.

Regular $899

CLOSEOUT SPECIAL! $599

C·COMM

Call Toll FREE Nationwide!

800-426-6528

(Incl. Alaska & Hawaii)

Wash. Residents: Add applicable sales tax. **Call: 800-562-6818**

International Orders:
Telex: 15-2391 C-COMM

C-COMM

6115 15th Ave NW, Seattle, WA 98107
(206) 784-7337

Orbit

September/October 1983
Volume 4 Number 4

***ORBIT* Staff**
Editor in Chief: V. Riportella, WA2LQQ
Assoc. Tech. Ed.: Dom Mallozzi, N1DM
Assoc. Editor: Harold Winard, KB2M
Asst. Editor: Bob Ruedisueli, W4OWA
Managing Editor: Bob Myers, W1XT
Advertising Dir.: Roger Soderman, KW2U

AMSAT Board of Directors
John Browning W6SP (Chairman), Tom Clark W3IWI, Rich Zwirko K1HTV, Jan King W3GEY, Pat Gowen G3IOR, Harry Yoneda JA1ANG, John Henry VE2VQ

AMSAT Officers
President: Tom Clark, W3IWI
Exec. Vice Pres.: V. Riportella, WA2LQQ
Sr. Vice Pres.: J. Champa, K8OCL
V. P., Engineering Jan King, W3GEY
V. P., Operations: Rich Zwirko, K1HTV
V. P. Special Projects: Bill Brown K9LF
Asst. V. P., Eng. (Spacecraft): D. Connors, KD2S
Asst. V. P., Eng. (System Analysis): Phil Karn, KA9Q
Asst. V. P., Eng. (R&D): S. Robinson, W2FPY
Asst. V. P., Ops. (S/C Ops): D. Loughmiller, KO5I
Asst. V. P., Ops. (User Services): Ralph Wallio, W0RPK
Treasurer: Roy Rosner, K4YV

Headquarters Office Staff
General Manager/Exec. Director: William Lazzaro, N2CF
Office Manager: Martha Saragovitz

Editorial Office: P.O. Box 177,
Warwick, NY 10990

Advertising Office: 221 Long Swamp
Road, Wolcott, CT 06716

AMSAT: P.O. Box 27, Wash., DC 20044.
Telephone: 301 589-6062
Telex: 248-566

Second Class postage paid at Waterbury, Conn. by *ORBIT*, 221 Long Swamp Road, Wolcott, Connecticut 06716.

ORBIT (USPS 041-850) is published six times per year for $15. (inseparable from membership dues of $24).

Copyright © 1983 by AMSAT. Contents may be reproduced without specific permission provided proper credit is given, unless otherwise stated and copies are sent both to AMSAT and to the author. Opinion expressed is not necessarily that of AMSAT.

CONTENTS:

Technical Features:

7 **Tilt Rather Than Twist**
By Al Zoller, W6OTE
An elevating experience!

9 **Satellite Orbital Elements**
By Phil Karn, KA9Q
A recognized expert unravels the mystery.

14 **Off-Axis Circular Polarization of Two Orthogonal Linearly Polarized Antennas**
By Martin Davidoff, K2UBC
Surprise may lurk for AO-10 users.

17 **UoSAT Mission Planning Update**
By Martin Sweeting, G3YJO
An interim report.

Informational Topics:

12 **Indoor Antennas and Mobile Station WAS the Hard Way!**
By Rick Dittmer, WH6AMX
If at first . . .

21 **Product File: The Yaesu FT-726R Transceiver**
By Al Brinckerhoff, WB5PMR
New unit from Yaesu is well suited to AO-10 operation.

29 **AO-10 Frequency Conversion Chart**

Departments:

5 **Ellipsis . . .** By Harold Winard, KB2M
23 **ASE Topics** By Bob Diersing, N5AHD
24 **AMSAT News**
19 **Worldwide Satellite Activity** By Pat Gowen, G3IOR
18 **W6 Space Philosopher** By John Browning, W6SP

Comets: ARRL Foundation Donates $10K (11), Behind the Cover (13), The ARRL National Convention (15), AMSAT Travelers in KP4-land (18), Late News from G3IOR (22), Dallas Ham-Com '83 (33).

Our Cover: The 43-meter (140-foot) Radio Telescope at the National Radio Astronomy Observatory, Greenbank, W. Va., Site of the May '83 Jansky/NRAO/AMSAT two-meter EME operation (K8HUH et al).

Here's the easiest, lowest-cost way to use the OSCAR 10 Satellite

New TEN-TEC Satellite Station.

It's easy. The new TEN-TEC Model 2510 simplifies station assembly, reduces the number of interconnections, and makes operating easier.

It's low cost. Eliminates buying separate converters and another HF rig.

It's full duplex. The 2510 is a 435 MHz, 10-watt SSB/CW transmitter and a 2-to-10 meter receive converter all in one package to give you full duplex transmit/receive functions in Mode B. It converts your HF station into an OSCAR station!

Just add antennas, rotators, a 100-watt "brick," and go. The 2510 transmitter section has a frequency range of 435 to 435.5 MHz (up to 437 MHz with optional board), adjustable ALC, and full controls. Main Tuning sets uplink frequency. Spot Control helps find your downlink signal. Drive Control, Microphone Gain, Band Switch, and Push-Button switches complete the front panel. Push-Button switches are: DUPLEX/MUTE (for duplex operation or for disabling receive converter during transmit); CW/SSB selects mode; USB/LSB selects sideband. The receive converter frequency coverage is 144 to 146 MHz (converted to 28 to 30 MHz) with dynamic range of 85 dB typical. Rear panel connectors are provided for antennas, amplifiers, key, 12Vdc input, and HF receiver.

Enjoy the most exciting event in Amateur radio today—with the new TEN-TEC Satellite Station. See your dealer or write for information to TEN-TEC, Inc. Sevierville, TN 37862.

Here's all you need to use OSCAR 10

1. TEN-TEC Model 2510 Satellite Station (requires 12Vdc @ 2A).
2. Your present 10-Meter transceiver or receiver.
3. 2-Meter, circularly polarized antenna, 10 dBi gain or greater (Cushcraft, KLM).
4. 435 MHz, circularly polarized antenna, 12 dBi gain or greater (Cushcraft, KLM).
5. Optional 50-100 watt 435 MHz linear amplifier (Mirage, Tokyo High Power).*
6. Rotators for azimuth and elevation (Alliance, Hygain/Telex, Spectrum West).
7. 12Vdc power source capable of supplying all equipment requirements.

**Output power requirements: refer to April 1983 QST. AMSAT recommends 500/1000 Watts ERP (effective radiated power) on 435 MHz. For example: 100 watts into a 12 dBi gain antenna yields 1000 watts ERP (assumes 2 dB feedline loss).*

Ellipsis...

*An Editorial by Harold Winard, KB2M**

The "Write Way" to Magazine Stardom

Inertia, that property of physical matter that must often be overcome in the interest of progress, has its counterpart in the field of publishing. It's the reluctance of many talented potential writers to take the first step in the process that ultimately leads to a published article. And it's not a fault either. Much like its physical counterpart, it's a natural and rather prevalent phenomenom.

But like overcoming inertia, making that first move towards the typewriter (or word processor) is the most arduous part of the effort. The work, once you get down to it, is not at all as fearsome as many believe.

The pages of *Orbit* must be, like the satellites themselves, a two-way path for the exchange of information. It is the large community of satellite users, and not us, who have the exciting story of OSCAR to tell. If you would like to have an important role in the satellite program and in the flow of information within the AMSAT family and beyond, here's your chance. Pick up your pencil, turn on your typewriter, or snuggle up to your Wordstar disk. There's nothing to it and I'm going to show you why.

The key to any good article is organization. Once you've overcome your groundless fears of writing and have selected a topic, you must develop an outline of what you will write. It doesn't have to be one of those monstrosities that my elementary school teachers made me grind out, replete with upper- and lower-case letters, numbers, symbols. Just a brief list of the important parts of your article and any important points you would like included is all that's required. That outline, if carefully thought through, will help keep you on track as you go from section to section. A meandering article, like a drunken sailor, doesn't go anywhere very quickly.

The lead — ah yes, the lead. The most challenging part of any story is the beginning. Since "Once upon a time" has already been used, you will have to think of a simple yet effective way to introduce your article to a reader. Now here's where magazine writing differs from what your high school teachers told you. The best story starts with the conclusion. That sounds somewhat strange but consider that there are no mysteries in amateur radio and satellite technology, just hitherto unknown facts.

Consider an example. An article that begins with "A simple antenna, made with $3 worth of parts, will greatly improve OSCAR Mode L reception" is a lot more interesting than one that starts "Prior to the 20th century, the helix antenna was rarely used for satellite reception." A bit of an overstatement perhaps but I think you have the idea. Tell all in your first sentence. Entice the reader with the exciting parts of your story, don't let him or her have to wade through boring history. By the time it's ankle-high, the reader will have retreated to the store to sample another magazine offering.

Now that should have been simple. If you have prepared your outline beforehand you know what the subject matter of your article is. From there, a couple of declarative statements gets you into the article and past the writer's worst stumbling block — the lead.

The remainder of the article should clarify and explain your lead sentences. Here it's best to proceed in a logical order. For example, take the reader step by step through construction procedures. Or start with the simple premise and lead up to the more difficult math. Remember that *Orbit* is read by a cross-section of the amateur community and many readers need a bit of background material before they can fully understand and appreciate the significance of your subject matter.

Here's another departure from what you have learned about good writing. You don't need a conclusion. Remember that you have already spilled the beans in your very first sentence. If your reader knows that your super GaInP 435-MHz preamplifier has a 0.1-dB noise figure and can be built with parts E.T. overlooked in the garage, it adds little to say so at the end of your article. It sounds a bit ungraceful to leave without saying goodbye but remember that *Orbit* , much like your brother-in-law, is here to stay. Most readers retain their copies for a long time and many articles are read and re-read several times. When you've said all you have to say, you've finished your article.

Now for some very practical suggestions. Articles can be submitted in just about any neat form. Typewritten or computer-printed manuscripts are almost an absolute necessity and double-spacing makes editing a whole lot easier. Artwork, schematics, block diagrams, and the like can be hand-drawn but here again neatness is important. Make sure all lines are clear and all components are properly labelled with parts values or numbers. If you have any doubt, ask a friend to review your work to see if all the lettering and connections are

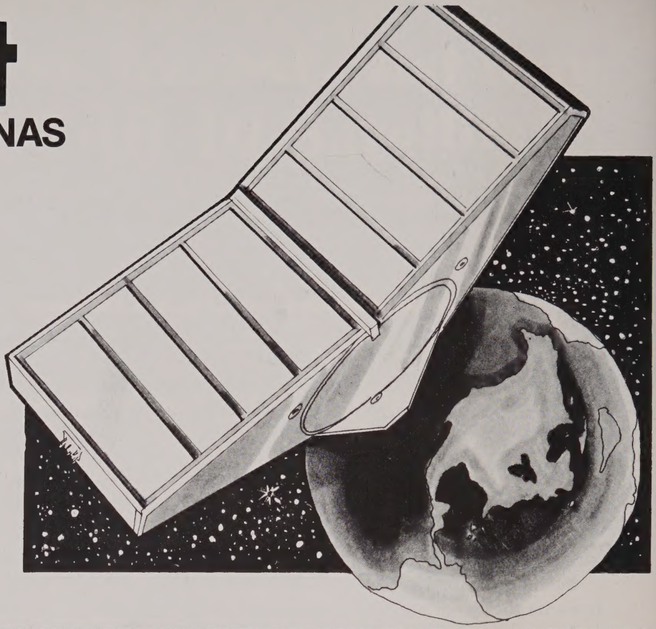
(Continued on page 13)

---

* *Assoc. Editor*

cushcraft

OSCAR SATELLITE ANTENNAS



Satellite communications for more hours a day with the OSCAR Phase III in orbit. . . that's exciting news for hams around the world! And Cushcraft is right there with BOOMER antennas to provide greater performance and more enjoyment at your station.

NOW is the time to get ready for OSCAR with Cushcraft's all new high performance 416TB 16 element 435 MHz BOOMER, featuring our new insulated elements, T-matched driven elements, built-in balun, special phasing harness, rear boom mount, and stainless steel hardware. This amazing antenna has true circular polarization right or left, and 12.5 dBd gain to give an extra margin of radiated power to the satellite.

The two meter antennas have been proven in many thousands of ham satellite stations. They feature excellent performance plus ease of assembly and installation.

	10 Element	**20 Element**	**16 Element**
MODEL	A144-10T	A144-20T	416TB
Frequency, MHz	145.9	145.9	435
2:1 SWR Bandwidth, MHz	>2	>1.5	>3
Forward Gain, dBd	10.5	12.2	12.5
3-dB Beamwidth, deg	52	38	34
F/B Ratio, dB	20	20	20
Boom Length, in (m)	70 (1.8)	130 (3.3)	80 (2.03)
Longest Element, in (m)	40 (1.0)	40 (1.0)	13.3 (.34)
Wind Area, ft² (m²)	.74 (.07)	1.42 (.13)	.5 (.046)
Weight, lb (kg)	3.5 (1.6)	6.6 (3.0)	4.9 (2.2)
Max Mast OD, in (cm)	1.50 (3.8)	1.50 (3.8)	2.0 (5.0)

OSCAR MOUNTING BOOM

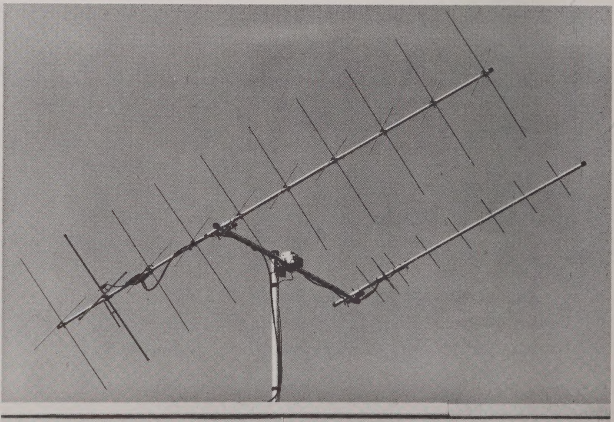
You can mount 2 meter and 70 cm twist antennas on the A14T-MB mounting kit. It has a 4.2 ft (1.3m) support boom with mount plate for the U100 elevation rotator. The easy way to a complete OSCAR station.

OSCAR PACK

Your complete OSCAR antenna system in one easy-to-use package. This is the convenient money saving way to a superior OSCAR signal.

OSCAR Pack includes 416TB (435 MHz uplink) and A144-20T (145 MHz downlink) Boomer Twist antennas plus the A14T-MB mounting boom. It contains the U100 rotator plate plus all hardware for antenna and mast mounting.

OSCAR Pack is your key to enjoyment of the latest phase of worldwide amateur satellite communications. Model AOP-1



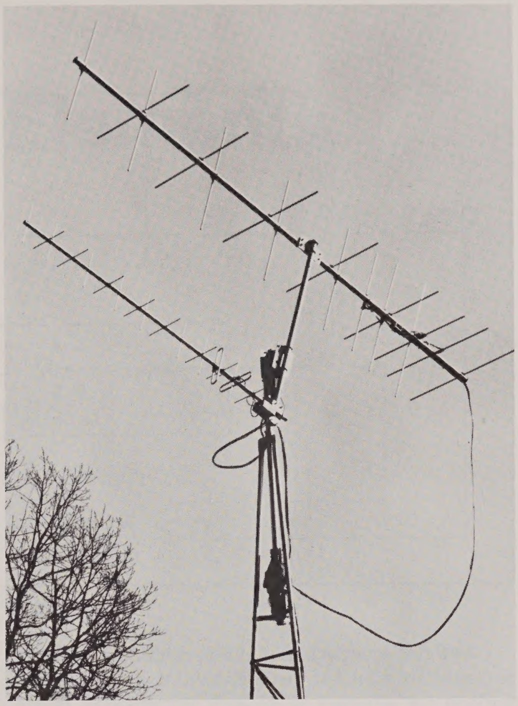
cushcraft
CORPORATION

48 Perimeter Road, P.O. Box 4680
Manchester, NH 03108 USA
TELEPHONE 603-627-7877
TELEX 953-050 CUSHSIG MAN

Tilt Rather than Twist

An elevating experience!

By Al Zoller, W6OTE



Most rotators adaptable for use as elevation drives torque or twist a horizontal boom to achieve the desired effect. Even with a well balanced system, individual elements suffer large torsional loads that can cause even the best U-bolt to slip or the strongest boom to permanently twist. Availability of suitable rotators of this type is also limited.

This situation prompted me to seek an alternate solution to elevate my Mode J and later my Mode B antenna system. At a vendor's booth at a local hamfest, a particular rotor caught my eye. It had adapters for a mast on both its top and bottom. These could be removed leaving just a cylinder with a hole pattern top and bottom. With only simple hardware, this device could be turned on its side and made to tilt a vertical mast with antennas attached.

◄ **The two Alliance antenna control boxes stacked together.**

Two flat aluminum plates were cut from an old rack panel. This material is generally just an eighth of an inch thick. It seems more than adequate for this purpose. Holes were drilled using the template supplied with the rotor for in-tower mounting. More holes were used for U-bolts that hold both the rotation azimuth mast and the tilting elevation mast.

In order for the control box to give a logical indication, the rotor was energized in a counter-clockwise direction to its stop. Unfortunately, this does not result in the adaptor plates lining up so that the tilt mast would be vertical. There are two solutions to this problem. The first is to simply rotate the hole pattern on one of the plates. The tilt mast is then vertical causing the meter to read south (or what will become its zero or horizontal position) when it reaches the ccw stop. The other method requires that the meter circuit be modified so that it reads zero at something less than maximum ccw rotation.

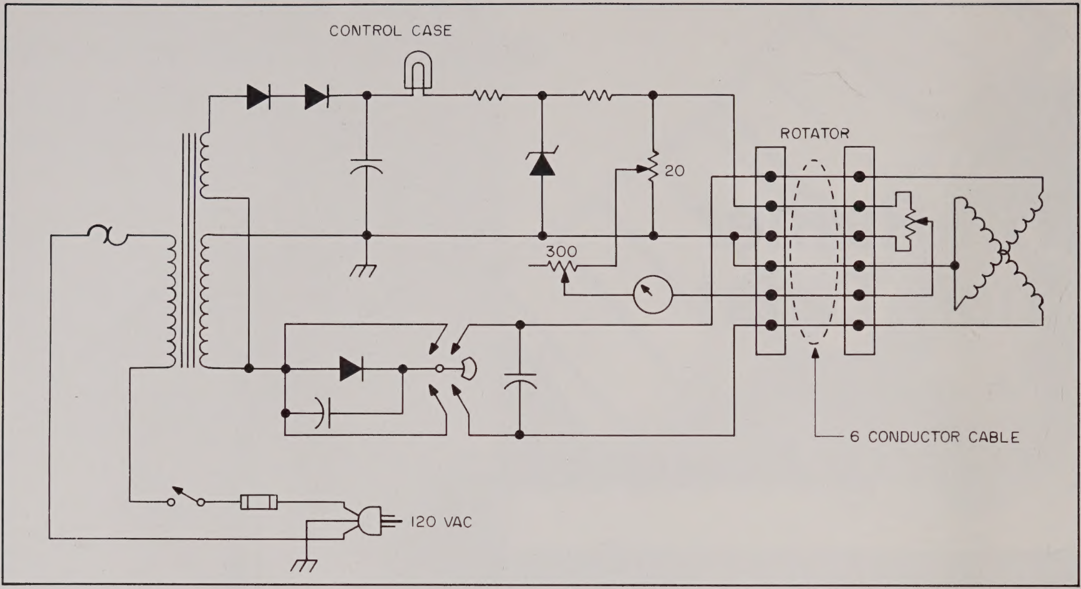


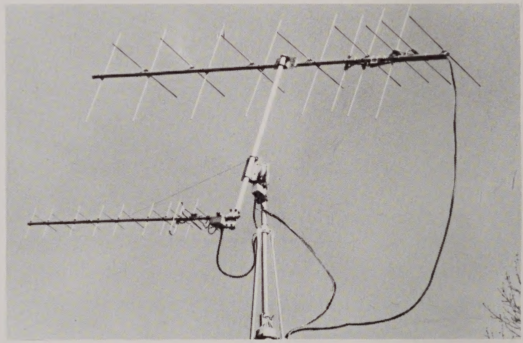
Fig. 1 — Circuit diagram for the rotator control box, as modified. Refer to the owner's manual for original diagram and for unmarked component values.

I took this approach as it allows calibration when the antennas are aimed at the horizon and tilting below the horizon for purposes of antenna maintenance and installation.

It was also desired to have the meter read full-scale when the antennas are tilted to the zenith thus making the full scale equal to 90 degrees. The 18 ohm resistor in the meter circuit was replaced with a 20 ohm pot. The center arm of this pot becomes the low end of the meter circuit and is the zero calibrator. The 470 ohm resistor from the full scale calibrator pot on the front panel is removed to provide full scale current when the rotator has only been moved through 90 degrees. The low end of the full scale calibrator is connected to the arm of the zero calibrator. This may not result in precise linear indication of antenna elevation but the error is undetectable. Finally the meter face was modified to indicate zero to 90 degrees. Old markings were removed with a solvent and new ones applied using dry transfers. Be especially careful of the meter movement if you try this as it is fragile and expensive to replace.

End-mounting the 70 cm antenna below the elevation rotor helps balance the system. A fiberglass mast from KLM was used as the tilting mast to keep conducting material out of the field of the 2 meter antenna. Note my 70 cm GaAsFET amplifier mounted just below the elevation rotor.

The rotator used for this purpose is the Alliance HD-73 which is readily available and costs about $100. Notice that I also use the HD-73 as my azimuth rotator. This system has been in use for over a year with no troubles. Many Mode J contacts have been logged and it is now used very successfully on AO-10.



Mechanical details of the W6OTE system.

W6OTE in the shack

Satellite Orbital Elements

By Phil Karn, KA9Q

A recognized expert unravels the mystery

There are several ways to compute motion of a satellite in a uniform gravitational field. Each involves solution of three second-order differential equations or their equivalent. This models the gravitational force on the satellites. Acceleration, the second derivative of position is a function of the current position. Integrating acceleration over time gives the change in velocity and integrating velocity over time gives the change in position. The position change "feeds back" into the process because as position changes, gravitational acceleration changes. Consequently the future velocity and position are affected.

One could track a satellite by solving these differential equations brute-force on a computer. To do so one must know the "initial conditions," here the starting position and velocity in each of three dimensions, of the satellite at a specified time (epoch). These six "constants of integration" are otherwise known as orbital elements. In rectangular (i.e., XYZ) coordinates, they would be called the state vector. In other words, knowing where the satellite is and how fast it's moving in a certain direction at a given time, one can predict all future positions and velocities.

Two-Body Motion

While this approach is workable and is often used when forces in addition to gravity are present, (e.g., kick motor thrust and atmospheric drag) a given position and velocity isn't very descriptive of the size and shape of the orbit. In addition, direct numerical integration on a computer is slow and prone to accumulated errors when carried on for long periods.

An alternative, the classical Keplerian element set, transforms the state vector into a different set of six numbers. Orbital prediction based on the Keplerian elements is generaly much faster and more accurate than brute-force numerical simulation. However, it must be remembered that it is well-suited only for the special case of two body motion where the following assumptions are made:

1. The central body (i.e., the earth) is massive with respect to the satellite. Although not a problem when dealing with artificial satellites, it means that the moon, about 1/80th the mass of the earth, requires modifications to the theory.
2. The central body is perfectly spherical and the force of gravity at any given point in space around the body points directly at the center of the body. The force magnitude depends, only on the distance from the center of the body. As we shall see, this is only a coarse approximation of the earth.
3. No other perturbing forces (other planets, atmospheric drag, rocket thrust) are present.

The path of a satellite in two-body motion follows a conic section: a circle, ellipse, parabola, hyperbola or straight line. Except for the straight line, (which is only a theoretical limit case) all orbital paths lie in a fixed plane containing the center of mass of the central body.

The most relevant orbit for our purposes is the ellipse. The classical Keplerian elements are properly defined only for this case. Since no "real world" orbit is ever PERFECTLY circular, this isn't too serious a restriction. A satellite in elliptical orbit does not stay at a constant distance from the central body. It's closest approach is called the PERIGEE, and the furthest distance it attains is the APOGEE (for earth orbits).

The Keplerian Orbital Elements

The following is a list of the classical Keplerian elements and their definitions.

EPOCH TIME, T: While not strictly an "orbital element," a time reference is needed in any element set to indicate an instant at which the remaining numbers are valid. The epoch may be chosen arbitrarily by the individual generating the element set but it is usually chosen approximately at the middle of the radar or other observation intervals used.

MEAN MOTION, N: The number of complete orbits the satellite makes in one day. The reciprocal of N is the PERIOD, P the time required to complete one orbit. Also, once the mean motion is known, a quantity called the SEMI MAJOR AXIS, SMA can be computed. This is defined as one-half the straight line distance between the apsides (i.e., the apogee and perigee). Occasionally, either period or SMA will be given in place of the mean motion.

MEAN ANOMALY, M: An indication of where the satellite is along its orbit at the epoch time. Specifically, it is a measure of *time* since perigee, expressed as an angular proportional quantity with 360 degrees (one full revolution) equal to one orbital period. For example, a mean anomaly of zero says that the satellite is at perigee; a mean anomaly of 90 degrees indicates that the satellite is one quarter period past perigee. Another way of looking at mean anomaly is as the time integral of mean motion. (Equivalently mean motion is the time derivative of mean anomaly.) Since mean motion is a positive constant (excepting drag effects), mean anomaly increases linearly with time.

It must be emphasized that since satellites in elliptical orbits do NOT move at a constant rate, the "angle" represented by the mean anomaly does *not* correspond to any measurable, physical angle. However, knowing the mean anomaly and the eccentricity (described below), one can compute the TRUE ANOMALY, v. True Anomaly is the angle (as seen from the center of the earth) between the perigee point and the satellite's current position measured in the direction of satellite motion. Likewise, knowing the true anomaly and the eccentricity, one can compute the mean anomaly.

ECCENTRICITY, e: The degree of "lopsideness"of the orbit. $e = 0$ would be a perfect circle; $0 < e < 1$ is an ellipse, $e = 1$ is a parabola, and $e > 1$ is a hyperbola.

Now we have determined the size and shape of the orbit. Next we need to specify how the egg-shaped orbital ellipse is rotated within its orbital plane with respect to an external reference.

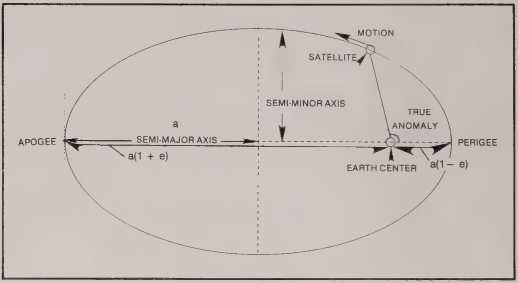


Fig. 1 — Motion within the orbital plane.

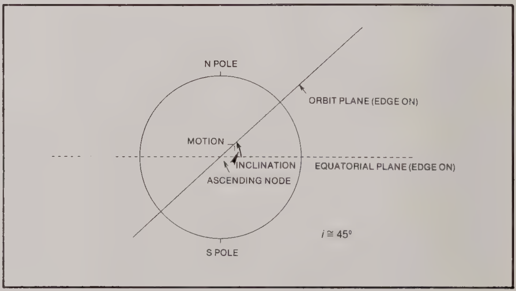
ARGUMENT OF PERIGEE, w: The angle, as seen from the center of the earth, measured in the orbital plane in the direction of motion of the satellite, between the equator and the perigee point. An argument of perigee between 0 and 180 degrees indicates that apogee occurs in the Southern hemisphere; between 180 and 360 degrees represents an apogee in the Northern hemisphere.

Next, the orbital plane must be oriented with respect to an external reference frame. Two values are required. They are:

INCLINATION, i: The angle between the orbit plane and the earth's equator. An inclination of zero means the satellite is always above the equator; an inclination of 90 degrees indicates that the satellite passes over both poles on each orbit.

RIGHT ASCENSION OF ASCENDING NODE RAAN or capital-omega: The angle, measured along the equator, between the First Point of Aries (a reference celestial longitude) and the point on the orbit plane where the satellite crosses the equator going northward. The First Point of Aries is defined as the point at which the Sun crosses the equator into the Northern Hemisphere at the first instant of Spring. "Right Ascension" is necessary here because this value refers to a fixed point in space; longitude measurements would depend on the position of the rotating earth.

Fig. 2 — Looking down on ascending node.



Perturbations

If one assumes perfect two-body motion, implying the absence of external perturbations such as the oblate spheroid earth, moon and sun gravitation, thrust, atmospheric drag, etc., all of the elements above except for mean anomaly would remain constant. Naturally the real world isn't ideal. Fortunately, several of the larger effects are easily compensated to reduce resulting errors.

The most important factor for most satellites is the nonspherical shape of the earth. It causes both short and long term changes in argument of perigee and right ascension of ascending node.

Additionaly, for low altitude satellites, drag can be appreciable. The first factor is easily computed from the other orbital elements; the second can be at best only approximated. The DRAG FACTOR, N-dot/2, indicates the rate of orbital decay by its effect on the mean motion, N. A drag-free orbit has a constant N; atmospheric drag will remove energy from the satellite and increase its mean motion at the rate of 2*N-dot revolutions per day. But as the satellite drops into a lower orbit, atmospheric drag will increase. Therefore, predictions based on just a single drag term are, at best, approximations.

Effects of solar and lunar perturbations can usually be ignored for low altitude satellites. More sophisticated models do exist, however, which take into account these effects. They are very useful in operational planning for geostationary satellites.

For further reading in orbital mechanics and prediction, I recommend the following to start:

Tom Clark, W31WI, "Basic Orbits," *Orbit* Magazine #6. This describes Tom's now-famous orbital prediction program written in BASIC that has been adapted to many different personal computers. Disk or cassette copies of this program are available from AMSAT for a nominal donation; write for details.

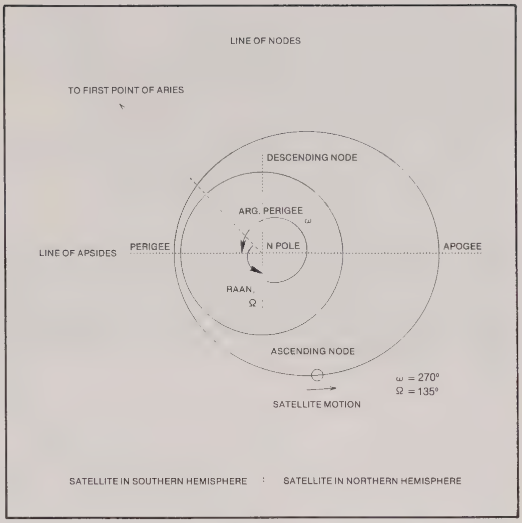


Fig. 3 — Looking down on the North Pole.

Bate et al, "Fundamentals of Astrodynamics," Dover, $6.50. This excellent paperback is designed for a college level introduction into the subject. Included are sections on orbital element generation which I used in the determination of Oscar-10's orbit after the kick motor burn.

Comets

ARRL Foundation Donates $10K

In the latest in a welcomed series of support moves, the ARRL Foundation has again expressed its support powerfully and tangibly. Represented by its Chairman W1QV, Robert York Chapman (Chappie), the ARRL Foundation presented a check for $10,000 to AMSAT Senior Vice President K8OCL, John Champa. The presentation took place at the ARRL National Convention in Houston earlier this month. (See photo.) AMSAT expresses its sincere and enthusiastic gratitude for the confidence, encouragement and commendation symbolized in this donation. The ARRL Foundation has donated $30,000 this year!

K8OCL accepts a check for $10,000 from the ARRL Foundation presented by W1QV as KO5I looks on.

Indoor Antennas and Mobile Station WAS the Hard Way

By Rick Dittmer, WH6AMX

Perseverence is a virtue many hams have come to know but few know it as well as Dan Greeson, KH6P. Hampered by severe antenna restrictions in his home town of Mililani, Hawaii, and really challenged by the signal-stopping Koolau Mountain range, Dan nevertheless stuck to his goal — the second Satellite Worked All States (WAS) award from the Aloha State. Dan did it and his story has a lesson for those who think that they cannot.

Dan is a Navy officer of some 18 years and currently is assigned to a submarine unit at Pearl Harbor. He lives with his wife and two children in a small town about 5 miles south of Wahiawa in central Oahu. Dan discovered trouble in paradise when he learned that Mililani's ordinances restricted antenna heights to no more than 10 feet above the ground. Further, the antenna could not be visible from the street in front of the house. With restrictions such as those, many hams would have taken up stamp collecting. Dan, however, knew there was a way.

KH6P has been a familiar call sign on OSCARs 7 and 8 since 1979 and Dan knew that his best shot at working the continental United States would have to be towards the northeast. The first step was a 10-meter beam in his attic, permanently set towards the mainland. The next step was a homebrew 4-element quad antenna positioned in the ham shack directly behind the operator position. Because it was within arms reach, the small 2-meter antenna needed only muscle-power for rotation.

Would the antennas be able to communicate through the satellites orbiting many hundreds of miles away? They sure did! Dan was able to work the majority of the United States with the exception of the extreme northeastern seaboard states. Although the indoor antenna system proved extremely successful, it was no match for the Koolau mountains, which had stymied the efforts of WH6AMX to obtain the first WAS award. (See "WAS-50 From Hawaii", *Orbit* 12, pp. 10-11.)

It was clear that Dan would have to go portable to the eastern coast of Oahu island if he was to work those few precious states remaining. A couple of DXpeditions to Waimanalo proved disappointing. A Mode A station was set up in a rented beach house some 50 feet from the shoreline. The contacts, however, were few and efforts

to hear 10-meter downlink signals were restricted by severe powerline noise. It was after those two attempts that Dan decided to remove his station from commercial power and go completely portable.

For several weeks, Dan put together KH6P/portable inside his car. The station included a 10-meter vertical antenna, a 10-element 2-meter twist, a TS700A 2-meter transceiver with amplifier, and a TS130 hf transceiver for reception of the downlink signals. All the equipment packed nicely into a small sports car, although not much room was left for the driver. Despite the inconvenience, Dan was able to get his mobile satellite station up and running in less than 20 minutes after arriving at an appropriate parking area.

The site Dan selected was in the town of Laie, on the northeast coast of Oahu. Powerline noise there was very low and the 10-meter vertical worked surprisingly well. In fact, the antenna was often as good as the beam and occasionally better for reception of the Russian RS satellites.

Although the equipment worked well, Mother Nature didn't and several trips to the Laie site were necessary. Schedules were made with stations in the needed states but atmospheric and ionospheric conditions plagued Dan's attempts to work those last few states.

But finally, during the July 4th weekend of this year, Dan exchanged signal reports and 73s with Dave Olean, K1WHS of East Lebanon, Maine for state #50. Adding to Dan's jubilation was a sense of accomplishment that despite antenna restrictions, mountain ranges, powerline noise, and Mother Nature, persistance paid off.

Ellipsis . . . from page 5.

correct. Your hand-drawn artwork will be redrawn by a professional artist who must be able to tell if that squiggly line is a coil or rather a laid-back resistor with no sharp edges.

Photos don't always tell a thousand words. Sometimes they tell very little and you should ask yourself whether yours is in that category. In general, a tight close-up of your project, showing how the plate-loading flapper works, is better than a shot of your curvaceous bikini-clad neighbor holding your 2C39 power amplifier for 1269 MHz. We'll print the former but send both anyway.

If you haven't decided to write an article for *Orbit* yet, here's some more reassurance. Each article we receive is edited for style and English usage. If portions can be improved with a bit of grammatical finesse, we'll apply same carefully. We encourage you to try your very best hand at plain, solid English writing but if science was your strong point, and not liberal arts, we'll help with an intensive rewrite. The subject matter of your article is most important. Our job is to help get it to our readers and if that means some heavy editing, we're prepared to do it.

If you're still unsure and would like some more information prior to penning your story, please get in touch with us through any of the addresses shown on the masthead. We will be happy to answer any questions on an individual basis. Good luck and good writing.

Comets

Behind the cover, WA2LQQ is caught in the act by W6SP.

Off-Axis Circular Polarization of Two Orthogonal Linearly Polarized Antennas

By Martin Davidoff, K2UBC

Surprise may lurk for AO-10 users.

Several competent users have reported observing that the polarization sense on AO-10 rf links switches from RHCP to LHCP, or vice versa, during relatively small (less then 20°) changes in the off-axis angle (angle between s/c z-axis and line joining s/c to ground station). When these reports continued after AO-10 was properly oriented my curiosity (disbelief?) led me to try some simple calculations which produced some interesting results.

A Simple Model

Consider the two linearly polarized beam antennas (A and B) shown in Fig. 1. Assume the E-fields of the two antennas are perpendicular and that they're fed equal power from a common source. For convenience, let the antennas be spaced one wavelength.

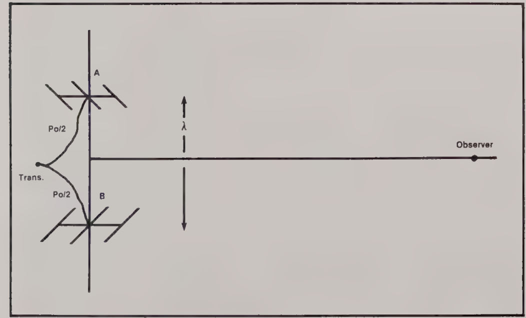


Fig. 1 — Two linearly polarized antennas. See text for details.

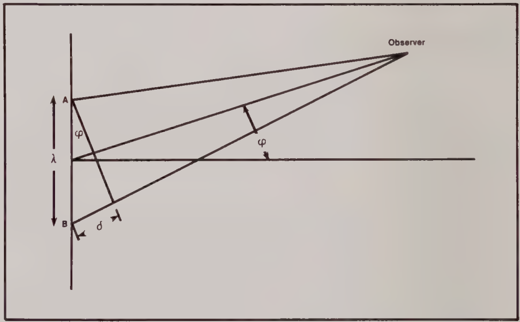


Fig. 2 — The observer is off axis.

If the antennas are fed in phase, or 180° out of phase, observer O will see a linearly polarized signal. If the signal to antenna B is delayed 90° or 270° then the observer will see a Circularly polarized signal (sense of polarization reverses between 90° and 270°).

Now consider Fig. 2 where the observer is off axis. Assume the antennas are again fed equal power in phase.

Let δ represent the difference in path length between OA and OB.

To first order $\delta = \lambda \sin \varphi$

What value of φ corresponds to $\delta = \lambda/4$?

$$\lambda/4 = \lambda \sin \varphi_o$$
$$\varphi_o = \pm 14.5^0$$

If we assume that the polarization is LHCP when $\varphi_o = -14.5°$ it will be RHCP when $\varphi_o = +14.5°$. If an observer is using a circularly polarized antenna LHCP will give the best performance when $\varphi = -7°$ (for example); RHCP will give the best performance when $\varphi = +7°$.

Conclusions

Since the antenna system on AO-10 is a phased array with spacing on the order of one wavelength the reported observations are entirely consistent with what one should expect from this s/c. However, since some ground stations also use phased array type antennas with booms spaced about one wavelength, some of the reports are probably due to misaiming of the ground station antenna.

Comments

This analysis leads to some interesting implications including:

1. If a ground station is going to use CP to access AO-10 at 2 m or 70 cm the antenna should be capable of *both* RHCP and LHCP. Otherwise, it's best to stick to linear polarization.
2. The AO-10 23 cm helix will not show this effect since it's not a phased array. (However, ground stations using phased array type antennas might report the effect if they don't aim correctly.) This is important since it means users don't have to include provisions for polarization switching in CP 23 cm antennas.
3. A ground station using a 2-yagi array, like the one shown in Fig. 3, can switch circular polarization sense simply by off aiming the antenna appropriately. By properly choosing antennas and spacing (moderate gain, wide beamwidth) the decrease in signal due to gain pattern roll-off can be more than compensated for by the increase in signal due to polarization matching.

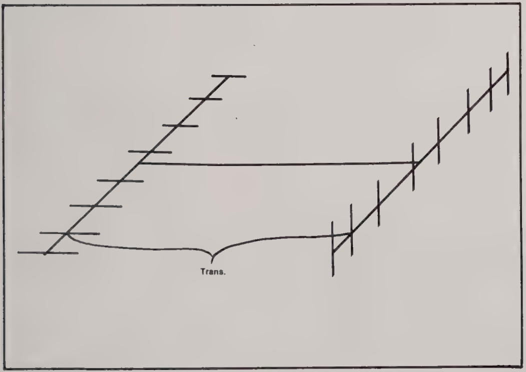


Fig. 3 — Two antennas mounted one or two wavelengths apart fed with equal lengths of coaxial cable.

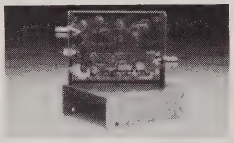
Comets

The ARRL National Convention

N5AHD (left) answering software question.

NEW FROM LUNAR

HIGH PERFORMANCE COMMERCIAL QUALITY UHF/VHF CONVERTER KITS



Professionally engineered using the high performance DBM, these kits are designed with the active VHFer in mind. All parts, components and circuit board are of the highest quality. Gold alodined case ensures circuit integrity. Each kit includes easy-to-read, fully illustrated instructions. VHF units use crystal control. UHF converters are tunable. Crystal control UHF models available soon. In the unlikely event of construction problems, complete factory back-up assistance is available from trained technicians.

Typical Specs:

Input freq.	144 MHz
Image rejection	−65 dB
LO specs	+7-10 dBm output
Conversion gain	15 dB
Noise fig (tuned min. N.F.)	1.75 dB
Noise fig (tuned max. gain)	2.4 dB
Harmonics	−50 dBi

MODEL	INPUT FREQ	OUTPUT FREQ	PRICE
RCK 6/10	50	28	$39.95
6/2	50	144	39.95
2/10	144	28	39.95
2/6	144	50	39.95
1.3/10	220	28	39.95
1.3/6	220	50	39.95
1.3/2	220	144	39.95
ATV	439	60	34.95
ATV P	439	60	39.95

Crystals for VHF models available $14.95 ea.

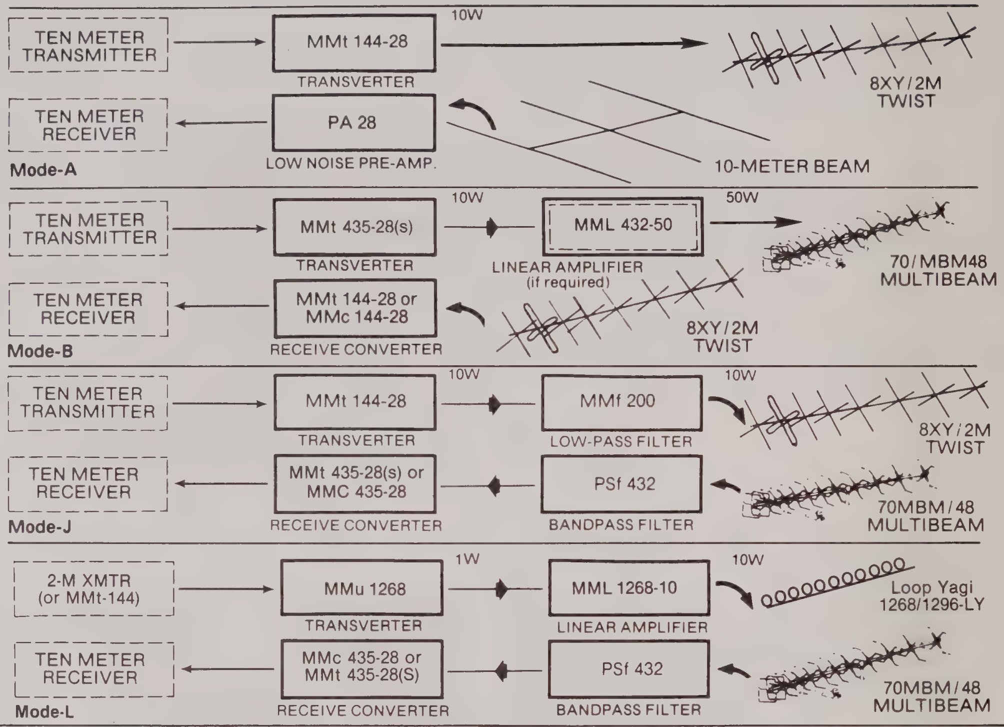
Other frequency conversions available. Specify requirements.

LUNAR electronics®

2775 Kurtz St., Suite 11,
San Diego, CA 92110

MasterCard VISA

OSCAR SYSTEMS FROM SPECTRUM INTERNATIONAL



CONVERTERS AND TRANSVERTERS FOR

OSCAR-8
UoSAT/OSCAR-9
OSCAR-10
(Phase III)

Specifications:
Output Power: 10W
Receiver N.F. 3 dB Typ.
Receiver Gain: 30 dB Typ.
Prime Power: 12 Vdc

Receive Converters:	
MMc 144	$59.95
MMc 435-28(s)	$69.95
MMc 435-28(TC)	$69.95

UHF Filters:	
MMf 200-5	$31.95
MMf 200-7	$42.95
PSf 432	$74.95

Mod. kit to adapt original MMt 432-28 to Mode-J oper: $26.50

AMSAT/OSCAR-10 Mode-L Equipment:
Transverters: 3 Models - selection of 10, 6, 2-meter i-fs.
Transmit only converters: 2 Models - sel. of 10, 6, 2-meter i-fs.
Receive only converters: 3 Models - sel. of 10, 6, 2-meter i-fs.
Antennas: Loop-Yagis, single, twin and quad stacking.
Tx Power Amps (Transistor): 3 Models, ½W/1W input; 8W, 10W, 17W output.

Attention owners of the original MMt 432-28 models: Update your transverter to operate OSCAR-8 and AMSAT/OSCAR-10 (Phase III) by adding 435-to-437 MHz range. Mod. kit including full instructions is $26.50 plus $1.50 shipping.

ANTENNAS

2-Meter 8 + 8 twist Model 8XY/2M	$62.40
Phasing Harness Model PMH/2C	$13.35
48 el. 70 cm Multibeam Model 70-MBM-48	75.75
88 el. 70 cm Multibeam Model 70-MBM-88	$105.50

(All prices FOB Concord, Massachusetts)

Send 40¢ (2 stamps) for full details of KVG crystal filters and other products to fill all of your VHF/UHF equipment needs.

Preselector Filters • Amplifiers • SSB Transverters
Varactor Triplers • Counters • FM Transverters
Antennas • Decade Prescalers • VHF Converters
Oscillator Filters/Crystal Filters • UHF Converters
AMSAT/OSCAR-10 Mode-B and Mode-L equipment

Master Card, VISA accepted.

Transverters by Microwave Modules and other manufacturers can convert your existing low-band rig to operate on the vhf and uhf bands. Models also available for 2m to 70cm and for ATV operations from ch2/ch3 to 70 cm. Each transverter contains both a Tx up-converter and an Rx down-converter. Write for details of the largest selection available.

si

Spectrum
International, Inc.
Post Office Box 1084R
Concord, MA 01742 USA

UoSAT Mission Planning Update

An interim report by Martin Sweeting, G3YJO.

A UoSAT Mission planning meeting was held at Surrey on May 23, 1983 to formulate a forward-look for the next three month period of UoSAT operations. The plan represents the overall mission direction rather than a specific operations schedule and remains flexible to operational evolution.

Stabilization/Attitude Control

Detailed analysis of spacecraft data has located the position of the tip-mass and boom following deployment and subsequent cable snag. Attempts to straighten the boom will resume, but if unsuccessful or without specific promise after June 10, 1983, attempts will be terminated and no further spacecraft time will be allocated to this program. The boom problem does not affect the user spacecraft operations dramatically and the finite spacecraft resources should be directed to other profitable experiments not yet fully exploited. The spacecraft can be allowed to remain in a natural spin state which is quite acceptable, while the possibilities (and desirability) of controlled spin or weak gravity capture are assessed.

H.F. Beacons Experiment

Following the termination of the stabilization program, the hf antennas will be deployed and the beacons activated.

Particle Experiment

Advanced software has been recently developed to enhance the value of the experiment data. When commissioned, the number of whole orbit observations will be increased.

2.4 GHz Beacon

The beacon has been activated recently and successfully received in the UK and Belgium. This beacon carries the same data as the 145 MHz downlink, and will be activated routinely at weekends, power budget permitting, and for other specific experiments.

CCD Camera and Video Experiment

The operational implications of closing the link between the 1802 computer and the Video Display Experiment will be analyzed in detail with a view to possible image processing of the CCD data and, particularly, uploading images and graphics from the ground. (In addition, this link provides access to a further 32k of memory for the 1802 for use in data collection and bulletins etc.)

This activity is highly desirable to stimulate interest in the CCD and video experiments and to evaluate the system for future spacecraft experiments.

Digitalker

The Digitalker experiment has been highly successful and generated a great deal of interest while, at times, proving operationally valuable. Efforts will be made to expand the scope of this experiment.

Scientific Magnetometer

This instrument has, thus far, been utilized primarily for spacecraft navigation however it is proposed to develop software to allow the study of the short-term, low-level perturbations to the geomagnetic field and their relationship to various radiowave propagation phenomena.

Digital Packet Radio Communications

In preparation for the proposed PACSAT spacecraft, packet radio experiments should be initiated between UoS and AMSAT-USA developing further the existing packet communications used in the control and data transfer on UoSAT.

W6 SPACE PHILOSOPHER

By John Browning,* W6SP

For one whose parents appear perpetually "middle aged", becoming "old" is difficult. Nonetheless, it's impossible to refute the onset of maturity when family members cease to provide exciting gifts for our anniversaries and holidays. Even people with interesting hobbies like amateur radio are not exempt from a period (Phase II) in which they are reduced to collecting birthday neckties. Donor rationalization generally goes something like, "Only he understands what he wants and he probably already has it anyway." Phase III begins when it is apparent to everyone that the supply of neckties on hand far exceeds lifetime requirements. Suddenly, ingenious gifts are again in vogue.

My transition to Phase III began in December 1982. Cautious removal of neat gift wrapping revealed a set of three cube-shaped sandbags accompanied by an instruction book entitled "Juggling for the Complete Klutz." It was the "Second Edition, Revised and Expanded." (The authors are Cassidy and Rimbeaux but the publisher prefers to remain anomonous.) The first thing learned from the experience is that "klutz" is a Yiddish word meaning "wooden block" which is derived from the Middle High German "kloz" for "lumpy mass". In English, the polite translation is "a clumsy person." It could have been worse.

The next lesson, "the drop," demonstrated conclusively that there were more sandbags than hands available — at least in my case. Eventually this klutz learned to juggle three items. The process was achievable because only one sandbag must be kept in the air. Most of the time the other two are firmly in hand.

The long, boring practice period encouraged mind wandering. Suddenly it became clear that life is just a large juggling game. We try to deal with more than we have in hand. The real trick is to achieve a balance among the activities we are juggling. Generally, we struggle with three main objects; family, vocation, and avocation. Each requires frequent attention or it will "drop." A good balance promotes health, wealth, and happiness; and possibly acclaim. The penalties of neglect are sometimes severe. We have watched some dedicated AMSAT volunteers as they allowed important objects to fall. When a dropped object is labeled "amateur space", we hear speculation regarding the possibility of "burnout." In reality, we have witnessed a loss of balance from over-concentration on one object at the expense of the others. A broad perspective was not maintained.

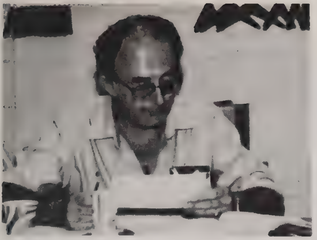
An AMSAT Board of Directors meeting serves to underscore the problem. Long hours are devoted to belaboring the many technical, financial, and bureaucratic frustrations and differing opinions involved in continuing progress. By the third day, most participants wonder why they are inflicting this experience upon themselves. The situation is much like that of an acquaintance who is a boating enthusiast. He recently served as a third crew member for a couple sailing their small vessel down the Pacific coast to Panama. While standing watch alone on deck during a cold, stormy night, he recalls observing, "Sometimes I have to remind myself I'm having fun."

We easily remember specific milestones in family and vocational endeavors. Occasionally we get to observe one in our avocational pursuit of enjoyment and relaxation. For amateur satellite enthusiasts, 6 August 1983 will never be forgotten. With years available to get ready for communications through our new high-altitude spacecraft procrastination prevailed. My OSCAR 7, Mode B station was rejuvenated during the final week. By the day of payload turn-on, one task remained undone — connecting the 12-volt control cables to the KLM antenna circularity switches. The traditional "unusual" California weather also prevailed! Never in history had Los Angeles recorded rainfall on the sixth of August. The record was broken with a vengeance. Nearby lightning discharges made the cable installation an exciting experience. But not as exciting as hearing my own signal echoing back from the satellite a few hours later. After talking with several old and new friends in distant places via AMSAT-OSCAR 10 on the first day of operation, no reminder was required. I knew I was having fun!

Comets

AMSAT Travelers Stop in KP4-land

On recent trips to ESA's Kourou, French Guiana launch site, AMSAT launch support team members often stop at San Juan to change planes. They are often greeted by AMSAT's PR friends led by KP4AA. In the photo, Carlos greets W4PUJ. Dick was on his way to prepare for the Phase IIIB launch. During the 1980 Phase IIIA launch campaign, Carlos played host to Marie Marr, who hand wired the harness for the Phase IIIA satellite and became an instant celebrity in KP4 with Carlos promoting the "USA Space Woman Technician" angle to the delight of the P.R. press and public alike.



G3IOR

Worldwide Satellite Activity

By Pat Gowen,* G3IOR

As this column is being typed, we probably stand at the threshold of the greatest ever communications advance in amateur-radio: AMSAT-OSCAR 10! It will provide a new, ultra-DX band, virtually free of propagational anomalies; no skip differential; independent of Solar cycle vagaries.

Realizing the enormous communications possibilities is up to the users. Their use of the minumum power possible and their willingness to share passband and power budget is essential.

Phase IIIB is co-incident with the likely loss of AMSAT-OSCAR 8. Although the 'RS' RADIO series continues to provide excellent Mode 'A' communications, the focus is the new super-satellite.

Over the three week period from prelaunch to post-launch my combined telephone and mail input exceeded fifty per day. Over 99% were requests for information on the newest bird. The same period produced a poverty of propagation on hf due to the declining sunspot cycle. Rarely were the AMSAT International Nets audible.

Thus, with adequate satellite coverage imminent, the newest satellite itself may well fill the role directly of this column in the future.

Alas, no news of OSCAR-8, although much searching is going on for catching a scrap of telemetry. Soon after the record-breaking GM4IHJ/W0CA Mode 'J' QSO, it went silent removing the opportunity of those keen to eclipse John and Nick by pushing the distance a few more miles.

OSCAR-9, despite the snag preventing the deployment of the gravity-gradient boom, is performing well. An adequate supply of telemetry, messages, and digitalker is present. The 7, 14, 21, and 28 MHz beacons are all on hf, but only the 21.002 MHz signal has been identified in Europe. The 7 MHz beacon has its problems, as Broadcast QRM on the European forty meter band is fierce. Few signals below S.9 are heard. As the boom was required for the 7 MHz radiator, the signal is undoubtedly weak. AMSAT-UK is offering a small prize for the first listener to positively identify this signal. (Send to G3AAJ, QTHR.) The 20 meter signal competes with a S.9 +40 dB commercial teletype station (as does the 14.282 MHz International Net) and cannot be heard at all.

On fifteen meters, the signal is excellent. It can be heard well at the antipodal point, up to 25 minutes sub-horizon, somewhat attenuated at low angles around LOS and AOS times. Due to the slant range through the ionospheric layers, it comes up to S.9 when elevations are greater than 35°. Strangely, the ten meter beacon has yet to be identified! The 2,401.000 MHz 'S' band beacon was switched on 19 May. It was heard by G3WDG and G4KGC peaking 15 dB over the noise on their GaAsFET (3 dB NF) front-end fed from a 8 dB gain feedhorn. The Doppler was some 500 Hz per second with deep QSB at times due possibly to the satellite spin. ON6UG used a MGF1400 pre-amp to an interdigital mixer and a 7 turn LHCP helical which gives him a full quieting fm signal with elevations of greater than 40°. The beacon is audible at 3° elevation but is very weak at these times.

Some exotic calls have been worked on RS-6 and RS-8, e.g., EK9C, RM9N. GB2NIJ emanated from the Norfolk International Jamboree operated by your scribe, from a meeting of 6,000 Scouts and Guides from many parts of the world. UI8AEG and VU2RM have been logged by the Robots, as have many more of the rarer calls that are sub-horizon to the transponder users. Following suggestions, RS3A, the 'RS' command station, is now tending to keep the transponders off on Wednesdays, in an effort to deter those who persist in using them despite the 'rules' of the game. We might even get those experiments going yet!

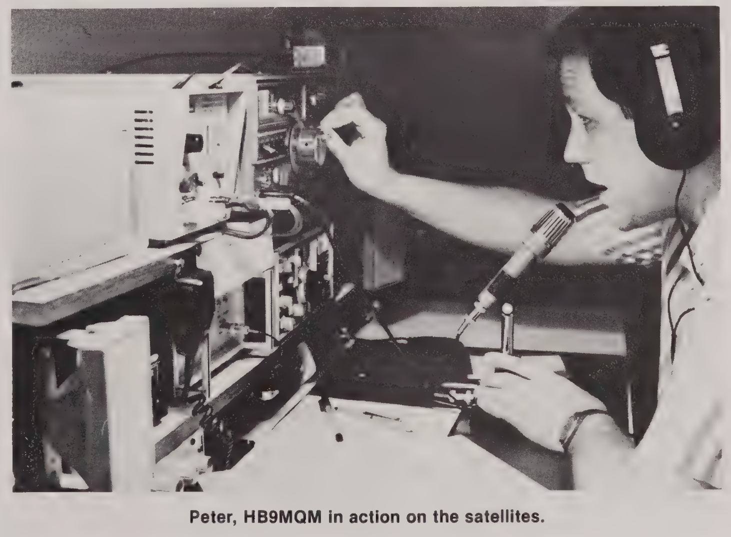
Early study of AO-10 has indicated propagation anomalies. Accurate az-el tracking by G8SMQ, in an effort to prove which of the many sets of Keplerian elements generated was the most viable, detected considerable abnormalities to the az-el curve calculated. SP9DH heard the satellite while it was over KH6 and many G's have heard good beacon signals while the satellite was well below 0° elevation.

Variations in the recorded spin-rate of up to 10% have been evidenced between stations measuring West to East against East to West possibly due to the added or subtracted Faraday rotation of the Van Allen belt. Noticeable variations on the anticipated RHCP have been observed often with periods of linear horizontal or LHCP giving a far superior signal. As the attitude of OSCAR-10 has yet to be finalized at this writing, serious and accurate work on this will have to wait to try to establish the behavior.

On the subject of using the satellite experimentally, I note that we have many SWL members and readers of *Orbit* plus many with callsigns who are never heard on the transponders. Perhaps as our active communicants on the satellites are so poor at relaying information, we should give a few words to those who are deeply interested in the satellites as observers. They may be interested in taking up some of the many valuable experiments possible.

To list a few of those that come to mind, the following are suggested:

1. SPORADIC 'E' Detection: When blobs



Peter, HB9MQM in action on the satellites.

of 'Es' appear between the observer and the satellite signal, rapid scintillation, Doppler changes, and extinction occurs, with rapid flutter. John Branegan, GM4IHJ, is exploring this phenomena, and has the tentative opinion that Sporadic 'E' clouds are lenticular in shape and rarely more than a few kilometers across. By observation of distant VHF TV and BC sources, he is able to verify the coincidence. Observers in other areas would be a valuable aid in this project. By phasing we would be able to determine if occurence is common over wider areas; hence Solar in origin.

2. SATELLITE TELEMETRY: Jack Ward, G4JJ, is studying the telemetry of many satellites and is establishing relationships between battery charge states, heating effects, and in/out of Solar radiation results. Telemetry from areas outside his access area are desired and individual work is suggested. The particular conditions leading to battery failure learned from telemetered data would be of great value.

3. SUB-HORIZON A.O.S.: Specific solar conditions produce good audibility of the satellites, even of vhf, and extinction at other times when line-of-sight. Work on association of these times and directions with Solar flux, M.U.F., the dusk to dawn path, WWV Solar factors, pre-auroral conditions, etc., could well bring about the specific constants knowledge that produces a re-angulation of the otherwise direct signal path.

4. POLARIZATION PATTERNS: The polarization of a satellite will often stray from that expected due to its passage through the earth's magnetic field. The change varies with Solar conditions and is easily detected with a good, linear Yagi. Establishing the position, path, effect and degree against WWV factors could prove to be a worthwhile study.

5. TWILIGHT PATH VARIATIONS: Signals "from" and "to" the satellites exhibit fluctuation, scintillation, and severe attenuation dependent upon the path being either from sunlight into darkness or vice versa. It is evident when the satellite itself is at the edge of the dusk-dawn path at the satellite height. A deeper study of the qualitative and quantitative effect upon the path would prove enlightening.

Other paths, e.g., TEP and Auroral Zone effects on rapid multi-Doppler give rasping signals through the path. Study here could lead to more knowledge about the phenomena.

John Branegan, GM4IHJ, has recently written a paper on the role of satellites for the listener. It is available free on request to the Media Network programme of Radio Nederland to give a start to those interested in observing the satellites in a deeper way. Some interesting references to early abnormal path effects can be found on pages 34 to 38 (inclusive) of *'73'* Magazine, November 1977. Some findings need further exploration by those that have the time and interest.

On the subject of SDX...Joe, WB0RLY, who puts such a good signal into Europe from the mile-high city of Denver, Colorado, delighted many with his satellite DX-pedition to Cheyenne, Wyoming. In particular, G3IOR, who worked him on both RS-6 and RS-8, ssb, for an all-time new rare state. W7AG in Arizona was heard on the RS-7 Robot (but not on the transponders) when it was in mutual range. Phil, W0KEA, from Western Colorado, went to his contest station site at 107°W and 39°15'N. It is on top of a 9,200 foot high peak called 'Snowmass'. At that height one needs to keep ones head down with satellites flying by! Phil hopes to operate from NE Utah during the Summer at 10,000' a.s.l. No doubt 0_2 will be provided!

Cam, HP1AC, is still putting Panama on the satellites. He has been able to rouse Brazil for South America but is amazed at the lack of activity from there. I do not know of a single Eu/S.America QSO since the dimise of OSCAR-7 and, other than TU2IT and TU2IE, with the EA8 lads, all is silent from Africa despite the mailing of many 'getting started on satellites' information to many countries there. Perhaps we shall do better with OSCAR-10?

While on the subject of programs for computers for satellites, many of you may not realise that apart from working the impossible on Mode 'J', GM4IHJ has come up with equally amazing fetes in the computer field. Using Sinclair basic on the 'Spectrum' 48K computer, similar to the 'TIMEX 2000' now available in the States and elsewhere, he has put together some superb material, of which I was fortunate to be selected as a tester. It would take several *Orbit's* to tell you all about them, but a review of some will be interesting to many of our members.

'RUSCON' is short for 'Russian Convoy'. On entering the date, it will list the EQX°W and Time, bearing and AOS of all the series RS3 to RS8 inclusive serialised in time. You may then select any orbit, when it will print the AZ and EL every two minutes form AOS to LOS.

'MCP3' is a full graphics display developed from the excellent elliptical orbit program by Tom, W3IWI, for Phase III. (*Orbit* No 6, March/April 1981). Upon putting in the date, a number of choices become available. A full Mercator map of the World is displayed, with the satellite shown at the sub-satellite point, with the Azimuth and Elevation to the observer. Each major World City in a range of Phase III is illuminated by a star, and the doppler corrected uplink and downlink is supplied. As the second choice, a full AZ-EL tracking table for every 15 minutes is printed, which scans once put up to a listing of all the World major cities, which go in and out according to the fact whether they are in range of you at that time show. The third choice is a series of sub-maps of each major subcontinent, e.g. SE Asia, Australia, South Africa, Europe, North America, South America, Oceania, etc. which may be screened individually, each showing the footprint of the satellite and all in range areas. The doppler is given, up and down, and elevation indicator and an azimuth indicator are shown in analogue as well as in digital. In well selected color, it is superb viewing as well as highly informative and very user-friendly.

'ELIP-8' does the same thing for OSCAR-8, but with the actual footprint placed upon the Mercator projection in addition. 'ELIPRS' does the same for all the USSR 'Radio' satellites, according to which one is selected. 'PROP9' does the same for UOSAT-OSCAR 9, but in addition, has the actual doppler corrected frequencies of all the beacons, and a superb great-circle map based on your QTH is given in addition to all previous. This shows the path from your QTH to the satellite, and prints on the World the dusk-to-dawn path (twilight zone) both on earth and at the height of the satellite, thus giving an excellent tool for investigating differential doppler, the dusk/dawn attenuator, scintillation, sub-horizon re-angulation, etc. The antipodeal point to the satellite is also printed, as a valuable aid to those wishing to investigate the unusual phenomena.

LUNAR • MICROWAVE MODULES • UHF UNITS • PARABOLIC • MUTEK • CUE DEE •
ICOM • KLM • MIRAGE • F9FT • SANTEC • ASTRON • TOKYO HyPOWER • PUMA • TAMA

LUNAR VHF/UHF Amps w/preamps
Simply, THE BEST

6M10-120 P 6mtr 120w Amp/pa (Export)	CALL!
2M4-40P 2mtr 40 w HT Amp/pa	109.95
2M10-80P 2mtr 80 w Amp/pa	175.95
2M2-100P 2mtr 100w Amp/pa	237.50
2M10-150P 2mtr 150w Amp/pa	263.95
2M25-150P 2mtr 150w Amp/pa	246.25
2M10-200P 2mtr 200w Amp/pa	316.75
1.3M10-80P 1.3mtr 80w Amp/pa	184.75
LUNAR GaAsFET Preamps	
PAGxxx 144, 220 or 432 GaAsFET	112.45
PAGxxxRPT as above for repeaters	112.45
MMPAGxxx Mast-Mounted GaAsFET	251.95
LUNAR Low Noise Preamps	
PAxx 28, 50, 144 or 220 MHz	31.50
PAIxx as above but RF Switched	43.95
Low Noise DBM Conv. Kits w/Xtal	54.90
LUNAR ATV Conv. Kits w/post amp	39.95
LUNAR/ARCOS VHF/UHF KW Kits	CALL!

Bonus Free Ups on all Lunar Amplifiers

MuTek Ltd. NOW AVAILABLE IN US
Low Noise - High Dynamic Range front-end boards with: Low loss relay, RF Amp, DBM, 6 pole Xtal filter, and IF amplifer for:

ICOM IC251 & IC211	131.95
Yaesu FT225 & FT221	129.95
SLNA144s RF Switched Preamp, 100w Max input, NF◄1db Gain 15db typ.	74.95
SLNA432s RF Switched Preamp, 100w Max, w/Helical filters NF◄1.4db	134.95
GLBA144e Mast-Mounted GaAsFET preamp, 1Kw PEP Max, includes lin. amplifier sequencer, Interfaces to all rigs!	249.95
MIRAGE D1010N 100w 432 Amp w/N's	275.00
Call for our low Quote on KLM & MIRAGE	
F9FT 1296 23el Yagi	47.35
F9FT 1296 Quad Array + PD + Frame	361.00
F9FT 432 21el Yagi	53.75
F9FT 144 17el Yagi *NEW*	CALL!
LUNAR LETTER VHF/UHF/EME Magazine	12.00

PARABOLIC - UHF UNITS - LABE

1296/144 3w Transverter	350.00
1296/144 1w Transverter	291.00
1296/28 1w Transverter	360.00
1269/144 3w Phase III X-verter	350.00
1269/144 1w Phase III X-verter	291.00
1269-1296 Dual tube 120w amp	302.00
1269-1296 Single tube 50w amp	219.00
1296 1 in 3w out amplifier	90.00
1296 1 in 15w out amplifier	359.95
1.2 Meter Dish Kit	89.95
1296 or 2304 Dish feed	70.00
1296 GaAsFET Preamp NF◄.9db 1st in Dayton '83 & W. Coast Conference '83	110.00
1269 Circular Dish Feed avail.	July
Power supply modules for single & Dual Tube Amplifiers avail.	July
KENPRO Elevation Rotors	CALL!
QUE DEE Antennas	CALL!
ICOM	CALL!

Super Deals ... Call ... Call

MICROWAVE MODULES

MMT144-28 2mtr transverter	199.95
MMT432-28s 432/435 X-verter	279.94
MMT 432-50s as above 50 MHz IF	279.95
MMT1296-144 1.3w X-verter	349.95
MMC144-28 2mtr converter	51.00
MMT432-28s 432/435 conv.	63.00
MMK1296-144 Low noise conv.	123.00
MML432/100 432 MHz 100w amp	379.00

Call on other MICROWAVE MODULE Equip.

**** ASTRON SPECIALS ****

RS7A	47.00	RS35A	127.30
RS12A	65.00	RS35M	147.90
RS12M	83.00	VS35M	165.50
RS20A	84.40	RS50A	194.00
RS20M	102.40	RS50M	211.00
VS20M	120.50	VS50M	229.00

**** SANTEC SPECIALS ****

ST144up ... 275.00 ST440up ... 290.00
Tokyo HyPower ... CALL!
Now U.S. Distributors SSB Electronics...Call

PRICES REFLECTED INCLUDE a 2% CASH DISCOUNT.
All prices FOB Mountaintop except were indicated.

SUMMER HOURS: M - F 9:00 am - 6:00 pm ORDERS ONLY
6:00 pm - 11:30 pm Technical info + ORDERS
Weekends Call Anytime!!

THE
VHF SHOP
Box 349 RD 4 Mountaintop, Pa. 18707 (717) 868-6565

MC/Visa accepted
Send 2 Stamps for 50+ page Catalog

PRODUCT FILE

The Yaesu FT-726R Transceiver

By Al Brinckerhoff, WB5PMR

Just about the time you think you have your station arranged the way you had planned, those crafty fellows from Japan foul everything up by introducing new, irresistable equipment to stimulate the salivary glands...and pry open your wallet. Enter the Yaesu FT-726R — exit my savings account.

I was first introduced to the FT-726R on May 28, 1983. I had no sooner cleared the front door at my local ham store, when Don (the sales manager) grabbed and pulled me over to the store's demo area. He had just taken the first one they had out of the box. My eyes rolled to the back of my head and Don politely placed a towel under my chin to prevent the rig from getting wet. What had been intended to be a 5 minute visit to the store to purchase some connectors, ended up being a 1 hour 45 minute play session. While driving home (yes, I forgot the *@$#&*#@* connectors) my mind was racing to figure out how much of my present station I needed to sell in order to make my dream purchase. On July, 2, 1983, I carried my FT-726R home with a grin that almost ripped my ear lobes off. I guess by now you are probably tired of my enthusiasm, so let's get down to brass tacks.

The FT-726R is an all mode tri-band transceiver capable of operating on 21 MHz, 24.5 MHz, 28 MHz, 50 MHz, 144 MHz, 430MHz, and 1.2 GHz depending on user configuration. The unit comes from the factory with the 44 MHz module installed. By using interchangeable rf modules the operator may select any one of the three bands installed (not all of the bands are available as of this writing). Each module provides 10 watts of power, and is easily installed in the main unit using five screws and three plug-in connectors. The brains of this radio is an 8-bit microprocessor chip that controls the ten channel memory capability (frequency and mode), allows instant transfer of memory to either VFO, and scanning of the entire band, selected parts of the band, or the memory channels. Additional features include audio speech processor, i-f shift and width controls, separate channel step tuning knob for fm, discriminator meter, priority channel, programmable repeater shift, clarifier offset, lithium battery for memory retention, and provision for optional narrow cw filter.

As the rig comes from the factory it is not capable of full duplex operation required for satisfactory satellite operation. In order to set the unit up to operate full duplex, two options must be purchased: 1) the Satellite Unit (which in essence is another i-f board) and 2) the 430-440 MHz or 28 MHz depending on whether you want Mode B or Mode A operation. Both of these units are easily installed requiring only a Phillips head screwdriver and the patience to read the instructions. After installing the Satellite Unit and the 70 cm rf module I was ready for OSCAR 10 Mode B. The front end on the 2M receiver has very good sensitivity and selectivity. In addition, the separate i-f shift and width controls have proven very effective and handy in tight situations on Mode B. One thing I noticed immediately in working OSCAR 10 Mode B was the stingy S-meter readings. I was receiving the general beacon stronger and with greater clarity than I had on my Icom IC-211, but the S-meter would barely make S-1 to S-2 when the satellite was at apogee.

As of this writing, I have discovered only two drawbacks to the radio. One is the lack of VOX. The other is that there is no send/receive switch (very handy when you're net control for the local AMSAT net on two meters). The second problem is easily solved. There is a RCA phone jack on the rear of the radio for plugging in a foot switch (which I have done.) I simply paralleled that line and installed my own send/receive switch. The first drawback of no VOX was addressed by me in writing to Chip Margelli, Vice-President Amateur Products Div., Yaesu Electronic Corp. Chip responded to my inquiry very promptly (I like that!!!). In his letter he gave the following reason as to why no VOX:

"VOX is something that had certainly been considered. However, when operating in the full duplex mode, we ascertained that a battle would emerge between the VOX and its own anti-VOX feature; the VOX is not supposed to respond to speaker output, yet the operator using a speaker could well have the volume turned up so high that the VOX would refuse to operate! This was an interesting effect to see!"

Personally, I disagree with Chip, since most satellite operators use headphones and therefore there would be no battle between the VOX and anti-VOX features. Even if an operator does not use headphones, most of us have been turning down the receive gain so as not to confuse ourselves by listening to the downlink delay. I hope the people at Yaesu change their minds about VOX.

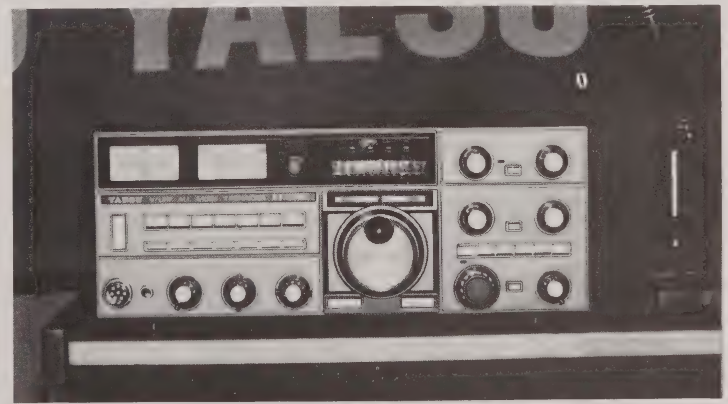
In the same letter I asked Chip about plans for a 1.2 GHz module and this was his response:

"Plans for 1.2 GHz are in a state of flux at the moment. We have completed a fair portion of the design work, but the packaging is still to be finalized. Needless to say, we will have application notes available soon outlining the simple interconnections between the FT-726R and the various 1.2 GHz modules already on the market. We frankly would be surprised to see a Yaesu module out before Christmas, but it is our intention to market such a device in the forseeable future."

In conclusion, I would like to share with you some of the features and capabilities of the FT-726R that are important to me:

1) The unit will provide 2M, 70 cm, and 23 cm full duplex capability in one package.
2) Continuously adjustable power output on 2M and 70 cm.
3) Full squelch on fm, ssb, and cw.
4) I-F shift and width.
5) RF gain control.
6) Programmable memory channels - especially helpful in fm operation.
7) Priority channel scan - also nice in fm mode.

(Continued on page 31)



The Yaesu FT-726R as shown on display at this year's "Dayton"

Comets

Late News on AMSAT OSCAR 10

From Pat Gowen, G3IOR

Thanks to the stalwart work and long hours by the AMSAT Command station AMSAT OSCAR-10, our newest and best satellite, has had its transponder on for a long enough period to be able to give some insight into its enormous possibilities. This, too, in time for a short report in this issue of *Orbit* just before deadline.

Probably the first QSO was made between DJ4ZC and PA0SSB when the monopole antenna was employed. Relatively high ERP levels and good receivers were required. Even before the change of attitude from second firing attempt to earth-beaming was completed, the high-gain antennae were deployed. A very noticeable improvement of sensitivity and downlink strength resulted. A few reports already came in evidencing OSCAR-10's use and capabilities.

Greg, ZS1BI, ran 35 watts to a vertically polarized 16 element home-made Yagi. With a vertical 12 element 2 meter Yagi feeding a rather noisy pre-amplifier to a FT221R, he worked F5AD at switch-on. This was prior to an antenna improvement. There followed K1HTV, W6MOO, KD8GC, W1NU, KE3KKA, KL7GRF, WB5DSH, WD4FAB, W9KDR, W5SXD, N8ANH, N4BB, WA8KEM, W3OZ, W2BXA, W4BE, GI8HXY, GJ8EZA, G6LIC, G4EZN, PA0SSB, PA0XMA, PE8DEO, F1JG, F1ANY, and ON7HP, all on ssb.

G3PXT, nee G8HWD, (Gordon now with his 'A' Class licence) also used ssb to work VK2AQG, VK4HAZ, VK5ZDR, VK5ZRO, H44PT and a host of European calls. He then loaned his FT78OR to G3IOR while he went away on holiday.

Your scribe promptly mounted a 13 element RHCP G3HUL Yagi (measured 16 dBi) for the uplink and a 7 element RHCP one for the two meter downlink on broomstick and rake handles, added a 25 meter run of H100 52 Ohm cable and an ex-TV 50 watt linear to work VK5QR, ZS6AXT, YU3BA, HG2RD, Z25JJ, SP9DH (very QRP), VU2RM (even more QRP with about 25 watts ERP) ZS6HS on cw, and GM4IHJ (a valuable communications link), OE9XXI, VS6HH, SV1AB, PY2BJO, ZS6UF, and LU7DJZ on ssb, plus a host of Europeans and many good AMSAT friends in the USA and Canada. An experiment made when the power "corrupters" were not active showed that 1 watt to my system, e.g. 20 W ERP could give a return of some 3 to 4 dB over the noise! In contrast, during the previous week, when your scribe was in as SWL capacity only, stations were noted and quoted as F1FHI running 10 watts to a 25 dB antenna, (3.6 kW ERP) 18CVS with 100 watts to 16 elements, (3.8 kW ERP) Z25JJ running 10 W to his 30 dB eight 28 element Yagis, which calculates to some 120 kW ERP! Many stations were running unneccessary levels in order to overcome the holes in the spin QSP produced by the employment of linear antennas, and to overcome the limitations of their poor downlink systems.

Most certainly, early experience is showing that enormous advantage can be gained by employing at least eight elements with switchable RHCP and LHCP on reception with a low noise pre-amplifier at the antenna to feeder junction.

G8SMQ, Norman, also ssb exclusive, worked VK5ZRO, ZS6UF, C30LAO, CT4KQ, SV1OE, CT1WW, XE1XA, FC6ABP, LX1SI, JY9CF, PY6ASV, 4X4AG, OY5NS, YU3UBQ, GM4IHJ, H44PT, over ten days, and snagged F1ANY, LX1SI, DK1OF, SV1OE, IV3IBX, VK5ZRO, HB9CAI, EI6AS, PE1DEO, ON7HP, OE1HAB and JA4CVA in the first two days of operation, thus making up for the three years that Norman has had his system ready for.

Rich, K1HTV/3, worked ZL1AOX and H44PT in the first few days, followed by QSO's into OE, G, OK, SP, JY, 4X, ZS, C30, CE, PY and LU, despite the limitations of his downlink system which is undergoing improvement.

Many D1/DJ, F, I G and W stations are active and UA3CR came up two days after announcing his intention to be on in the 14.280 MHz Saturday AMSAT Eu. net to PA0DLO. G3AAJ put his eight watt Belcom rig into a band 5 TV antenna, complete with a long run of TV coaxial cable, to get a good RST 569 signal on the downlink.

W1AW is running bulletins on 145.835 MHz already. Due to the shift of passband the L1 channel is now 145.830, and L2 145.840 MHz. The band center becomes 145.901 MHz. The vhf enthusiasts meet on 145.950 MHz to discuss EME, MS, Es, Tropo, and make schedules, while the AMSAT Net and calling frequency is 145.957 MHz downlink. Already active are W6SP, W3IWI, K1HTV/3, JA1ANG, WA2LQQ and a host of AMSAT stalwarts.

The OSCAR-10 orbit repeats after nineteen days within one degree but with a slightly higher Northern Apogee, reaching the 26.17°N inclination point about April, 1984, to then proceed South again to the equator in Spring 1985, then on to 26.17° South. Each day the Apogee shifts East by some 9°+; therefore some 45 minutes earlier each day.

OSCAR 10 EQUIPMENT

- **Antennas/Accessories**
  KLM 420-450-18C, 143-150-14C, circularity switches, splitters, fiberglass mast/booms
- **Rotors**
  Kenpro KR400, KR500
- **Amplifiers**
  Mirage D1010(N), D24(N), B1016, B3016
- **Preamps**
  Lunar GaAsFET, regular or mast mount, 2m, 70cm
- **Power Supplies**
  Astron 12 Vdc Models from 4A to 50A; metered and nonmetered

★ **New ICOM IC-471A**
all-mode 430-450 rig. Fantastc!

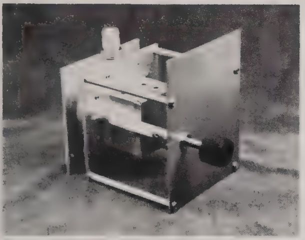
★ **New ICOM IC-271A**
all mode 2-meter rig. Marvelous!

Quality Assured!

KJI Electronics
66 Skytop Road
Cedar Grove, NJ
07009

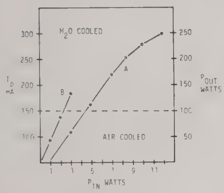
Call 7-11 P.M.
201-239-4389
VISA/MC ACCEPTED

Cavity Power Amplifier 1240 to 1300 MHz



- Single 2C39/7289 tube.
- 50-ohm in & out; no stub tuner req'd.
- 250 watts maximum output.
- Tunes the entire band with front panel control.
- No exposed high voltage while tuning.
- Ptfe (Teflon) anode tuner, no moving metal parts.
- Convenient remote mounting.
- Silver plated 1/8th inch copper plates, heavy aluminum construction for thermal stability.
- Supplied with H_2O cooling and bias switching information.
- Obtain max. OSCAR 10 ERP with one watt drive and 6 foot loop Yagi or a quad helix.
- Over 14,000 hours of continuous operation to date.
- Adjustable output loading control.

LCA AMPLIFIER PERFORMANCE *



* E_p 1360V, Ig @ 250 W = 50 mA
H_2O COOLING AT .3 GAL/MIN.
A - TUNED FOR POWER
B - TUNED FOR MAX GAIN

- Model LCA without tube $275
  Delivery 14 to 45 days.
- Screw on H_2O jackets for 2C39/7289, anodized aluminum, with gasket . . $15

Other Angle Linear Products:

- GaAsFET preamplifiers on any freq. up to 3 GHz.
- Time delay sequence generators for automatic T-R switching, coaxial relay and preamplifier protection.
- Write for data sheets.

Prices and specifications subject to change without notice. Calif. residents add 6½ percent sales tax.

Chip Angle, N6CA (LM 135)

Angle Linear

P. O. Box 35
Lomita, CA 90717

ASE Topics

Notes from the AMSAT Software Exchange

By Bob Diersing, N5AHD

Helpful Information On Various Versions Of W3IWI Orbit Program As Distributed By ASE.

With many copies of the various versions of the W3IWI orbit prediction program now in the hands of users, there is a pattern of common problems developing. Some are the fault of the various programs, some are the fault of the documentation, and some are trouble between the keyboard and the chair. Here are some helpful hints:

Radio Shack TRS-80 Model III

The most common problem encountered in this version is the failure to specify 2V or 3V (either is OK) in response to the HOW MANY FILES? question when starting in BASIC. Failure to do this results in various errors in the OPEN statement for the element set and station data files. This information is given in the operating instructions but some programs have been mistakenly shipped without the documentation.

A few of the programs shipped were configured to run in DRIVE:1 on a two-disk system and therefore will not execute properly on an single-disk system. To solve this note the statement in which the error occurs, which will be an OPEN statement, then delete the drive specification from the statement. For example, ELEMENTS/DAT:1 in the OPEN statement would become ELEMENTS.DAT. Leave the other parameters of the OPEN statement as they are.

When entering element set data with the program ORBITSOO/BAS, the EPOCH YEAR is simply 83 rather than 1983. Newly shipped versions have a reminder to this effect in the prompt.

In line 157 the variable I9$ which is a mask for a PRINT USING statement should have one additional position to the left of the decimal place. The new code should read I9$ = "#####.########". Other masks in line 157 should remain the same. This error will not keep the program from running nor produce incorrect results. It only results in a % sign appearing in front of some values which will not fit in 4 digits.

Line 1590 reads IF D3 = INT(D3) THEN TO = D3 + H3/24 + M3/1440 + S3/86400! ELSE TO = D3. The ! should be deleted from the constant 86400. This is one of those that takes a change of circumstances to uncover. Some BASICs use the ! to designate a single precision floating point constant. This bug has not caused problems before this time because NASA element sets seldom (if ever) have an epoch day with no fractional part. Millstone Hill elements lately have been values such as 189.00000000 so the problem handling an integer day surfaced.

Radio Shack TRS-80 Model 4

Versions of the program specifically for the TRS-80 Model 4 have only recently begun to ship since this is a fairly new machine. Those who have traded in their Model III or upgraded the Model III to the Model 4 and would like to take advantage of the 4 MHz. clock speed can convert their Model III programs by doing the following:

While running in Model III mode, save both programs as ASCII files. To do this, load the program in BASIC the usual way and then SAVE "ORBITSOO/BAS",A. Do the same with the program ORBITSO1/BAS.

Boot up with TRSDOS 6.0 and place the disk with the Model III ASCII files in DRIVE :1. Use the CONV command to convert to TRSDOS 6.0 files and place them on the TRSDOS 6.0 system disk. The command to do this is CONV ORBITSOO/BAS:1 :0. Again, repeat the process for ORBITSO1/BAS.

Load BASIC on the TRSDOS 6.0 system and then LOAD and SAVE both programs in the usual way. This converts them back into the translated BASIC form but for the new version on BASIC.

The first time you run ORBITSO1/BAS it will crash everyplace the exponentation operator occurrs. Don't panic. On the Model III BASIC the operator was [but on the Model 4 it is —. You might say that is nice but where is it on the keyboard? The — is produced by the CLEAR and ; (semi-colon) keys together. Just let the program complain and fix all of them one at a time being careful to make no other changes in the statements involved. SAVE the program again and you will be ready to go.

IBM Personal Computer

The only common problem with the IBM PC version is similar to the Radio Shack Model III problem specified earlier. When loading BASIC on the IBM PC use:

BASICA /S:256

This again sets up the proper size file buffer which is 128 bytes by default. The symptoms of this problem of the IBM PC are ILLEGAL FUNCTION CALL errors in the OPEN statements.

We apologize for any inconveniences caused anyone. Anyone needing help can call me at home at (512)- 852-3196 before 10 PM Central Time, at ASE BBS (512)-852-8194.

AMSAT News

Organizational items of interest to all members of the Radio Amateur Satellite Corporation

Amateur Radio's Newest Frontier

July 12, 1983 was filming day at the Goddard Space Flight Center. The crew shooting the new ARRL film, *Amateur Radio's Newest Frontier,* were on hand. Several pictures of the event are given throughout this column.

Booster Flaw Delays Ham-In-Space

The National Aeronautics and Space Administration (NASA) last week announced its decision to delay the STS-9 flight of space shuttle Columbia. The announcement came on the heels of revelations that disaster was barely averted in STS-8 which flew in September. Dr. Owen Garriott, W5LFL, is manifested aboard STS-9.

NASA said defective insulation material on the solid fuel booster nozzles had very nearly burnt through on STS-8. According to the authoritive journal *Aviation Week and Space Technology*, STS-8 came within a few seconds of cataclysm because the nozzle ablative material burnt through to within a fraction of an inch of the nozzle itself, a combination of steel and aluminum alloys. The nozzle would have burnt through in about six seconds officials stated. Had that happened, the thrust vector would have been severely offset making control, even under computer assist, virtually impossible. Experts thought recovery from the resultant attitude unlikely.

Tests of ablative material from the same lot used on the STS-8 boosters showed the problem was general. Apparently the ablative material on the STS-9 boosters are also suspect. An ablative is a substance (such as aluminum silicate) which is designed to protect vital spacecraft components by absorbing and dissipating heat by phase change from solid to liquid and from liquid to vapor. The suspect ablative failed to provide the required protection margins.

With the delay of STS-9, the ham-in-space mission of Dr. Owen Garriott is delayed as well. Garriott was to operate a two-meter FM transceiver from Columbia during several orbits during the scheduled 178 orbit flight. Hams around the world have been alerted and thousands are preparing for the opportunity to try to work the first amateur radio space station. Now those plans will have to go on hold.

Rescheduling STS-9 may prove a major headache. NASA wants to turn the mission around and launch 28 November. ESA wants to wait until Feb. or March. Program officials believe repairs to the boosters can be done and the shuttle restacked for launch by then. But there's a serious hitch. The European Space Agency (ESA) has a major scientific package aboard. Its Spacelab houses millions of dollars in scientific packages not to mention the years invested in preparing them. Spacelab's experiments critically depend on precise timing of the launch. Especially critical is the phase of the moon. Many of the experiments depend on low light levels for optimum sensitivity. That means no moon in sight. Moreover, the earth's albedo (reflectivity) increases markedly with snowcover and winter-associated fogs; another negative for a November launch. ESA is pressing for a slip to February when favorable light conditions will next occur.

Making rescheduling yet more difficult is the imperative of having proper lighting conditions at potential emergency recovery sites such as Zaragosa, Spain. That means sunlight since this site has inadequate artificial runway lighting.

All this makes for a planner's nightmare. NASA urgently needs to get on schedule as soon as possible to avoid further schedule slips. Important paying customers and national security payloads cannot wait. NASA wants to go at the first possible moment. ESA, on the other hand, has its most ambitious science complex at stake. According to a Lockheed scientist quoted in *Science News*, "If the shuttle is launched in November, 50 percent of our experiments would be eliminated and the other half would suffer greatly." The scientist is principal investigator in an experiment to study polar auroras with light sensitive instruments.

On a grander scale yet, the rescheduling dilemma may exacerbate the keen, evolving competition between NASA and ESA for paying launch customers. By pressing for a launch delay until favorable lighting conditions which next occur in February, 1984, ESA may be attempting to concurrently strengthen its own hand. Its Ariane L7 mission last week scores a major victory with the successful launch of a large Intelsat F7 communications satellite to a geosynchronous transfer ellipse. The prior launch, L6, carried AMSAT-OSCAR 10 and ECS-1 to orbit last June 16. With two consecutive successful launches, Ariane is fast becoming viable shuttle competition; a fact certainly not lost to the NASA managers. Thus the apparent desire in Washington to get STS-9 off the pad as soon as possible, science and ESA notwithstanding.

Amateur radio operations on STS-9, although a focus of broad interest in the ham world, ride on the fortunes of decisions of managers concerned mainly with issues far greater than those of the ham world. Yet to the youngster whose imagination has been spurred by the chance to reach out and be

At the filming session, (l. to r.) W3GEY, W3IWI and K6DUE

part of the grand space romance, it is a bitter pill to realize that his long-awaited, once-in-a-lifetime shot is in jeopardy. However, this apparent set-back should be tempered by the realization that W5LFL likely will just be the first of many hams-in-space. NASA and ARRL officials and Dr. Garriott himself has told us that if things go well for W5LFL, his footsteps may be followed soon by several others in a succession of opportunities for the general public (hams) to join in with space activities by talking directly with astronauts in orbit.

Meanwhile, ARRL and AMSAT plans to support STS-9 have been put on temporary hold pending determination of the new launch date. *Amateur Satellite Report* #65 had been planned as a special STS-9 issue. It will run about 2 to 3 weeks ahead of the launch when it's scheduled. November *QST* features many aspects of the STS-9, Ham-in-Space story including a cover photo. It too may need to be recycled upon rescheduling of STS-9.

Net Manager W8GQW Announces Changes and Additions

AMSAT Net Manager Wray Dudley, W8GQW, has announced that Bob McGwier, N4HY, of Providence, RI, will join the team of Net Control Stations. Bob is at Brown University in Providence. His first tour of duty on the 20/15 meter nets will be on 2 October. Welcome aboard, Bob!

In other activity on the nets, W8GQW announces the popular SEASAT net based in central Florida has moved its operations to an Orlando repeater, W4OHL/R. The net will meeet each Wednesday evening at 8 P.M. local time. The frequency is 146.70 with standard offset. This net formerly operated on 40 meters but poor propagation combined with QRM motivated the change according to SEASAT NCS WB4ZXS.

Similarly, Bud Schultze, W6CG, has decided to move the AMSAT Southwest Pacific Net to 15 meters. Bud cites declining conditions on 28.878 MHz as the key to this change. The net will continue to convene at 2200 UTC Saturdays but will now occupy 21.280, the standard AMSAT 15 meter frequency. Additionally, Bud will occasionally transmit this net on AO-10 on the ACNF (AMSAT Calling and Net Frequency), 145.957 MHz. He hopes to attract stateside check-ins as well as the prime-targeted ZL-VK-Western Pacific zone.

W8GQW explains that these nets are part of a worldwide system of AMSAT nets which seeks to bring the latest amateur space news to interested individuals. A comprehensive net listing appeared in *Amateur Satellite Report* 48/49, for 27 Dec. 82.

QRP Day Debuts to Rave Reviews

AMSAT OSCAR 10 operations took a very favorable turn this past week when on Monday, 12 September, the first QRP day was scheduled. Initial reports received by AMSAT officials indicated the event was a notable success. Maximum allowable ERP (effective radiated power) for QRP was 100 watts with the range of 50 to 100 watts put forth as a goal. Many stations apparently were delighted, if not astonished, to learn that good QSOs could be made using as little as 20 watts ERP or less.

While those with higher power available mostly obliged by turning down the "wick" to the recommended limits or less, those with 10 watts or less of 435 rf were well-pleased that their signals were now being heard and copied well. This resulted, according to AMSAT, because the satellite receiver AGC was no longer forced to cut back the transponder transmitter power. AGC activity and the resultant cutback of receiver gain occurs when too many excessively strong signals appear in the uplink passband. The consequence to lower power stations is most severe. Since the receiver sensitivity is reduced, only the stronger signals are transponded to the downlink. The irony lies in the fact that at the point where AGC cut-in occurs, the strong don't get stronger; the others simply disappear into the noise as all the available power is "sucked up" by a few uninformed QRO operators. So when QRP Day demonstrated so well that less than 100 watts ERP was all that was needed, a general glow of satisfaction set in.

It appears that the word is getting around very quickly that QRO operation is not only impolite; it's a mark of an inexperienced operator; or worse!

Many of the initial problems with newcomers hearing the bird are disappearing too. We have learned that 2 meter preamp sales are very strong as the importance of "hearing" well becomes impressed on the psyche of hamdom. Quite a number heard on AO-10 have explained how well they have found their system to work with the preamp mounted at (or close to) their antennas.

With the first AO-10 QRP Day now history and a huge success as measured by the level of cooperation demonstrated, the weekly event seems sure to be one of the most popular operating features of the satellite. Spreading the spirit of cooperation seems the next challenge. To encourage development of the QRP spirit for AO-10, WA2LQQ is formulating a QRP engineering achievement award. The award would be available to all those demonstrating superior Mode B or Mode L "hearing" capability. Although the award is in the early planning stages, it would, according to WA2LQQ, be structured much as the ARRL Frequency Measuring Tests (FMT) were. Top awards would be made to those stations able to copy calibrated downlink signals very much below "normal" levels. Complications in structuring the award (such as assuring fairness by compensating/accounting for variations in range loss) remain to be detailed. More on this Engineering Excellence Award soon.

Several would-be QRP operators pointed to a potential dilemma. They point out that often the adjustment of uplink power is not as easy as rotating a pot. That is, many rigs have no audio gain controls for ssb and/or no level control for cw. Typically the operator might be able to manage three distinct power levels 10 dB apart. In this example he might have a 70 cm transceiver with normal output of 10 watts and low power position of 1 watt. He might also have a 100 watt 70-cm amplifier providing 10 dB gain. His output can then vary in 10 dB steps at 1, 10 and 100 watts. Given an antenna gain of 13 dB and a transmission line loss of 3 dB, this station could radiate 10, 100 or 1000 watts ERP. But nothing in between. Experience has shown that often a level of 100 to 300 watts ERP is just fine. What does this individual do?

WA2LQQ (left) and K6DUE discuss the plans at the lab.

Fortunately the technical solution is not a difficult one. What is called for is an attenuator "pad" that will reduce the ten watt transceiver output by a few decibels. (Attenuation could also be accomplished at the output of the amplifier but that is a bit impractical.) A lumped constant pad rated at 10 watts and presenting a good match to 50 ohms at 435 MHz is not a trivial matter although with care it can be built in the workshop. A design for a step attenuator based on varying lengths of relatively high-loss coaxial cables is planned for *Orbit* magazine soon. This should help those seeking the better "granularity" of power flexibility desired for those conditions where maximum power is definitely too much but medium or lowest power is not quite enough.

QRP days will continue each Monday UTC with uplink power not more than 100 watts ERP. Watch for further details on progress of this exciting new avenue of enjoyment on AMSAT OSCAR 10. And watch for announcement of the Engineering Excellence Award for those demonstrating superior Mode B or Mode L receiving capability.

Mysterious Mode B Shutdown Causes Concern

A baffling shutdown of AO-10, Mode B, late Friday, 30 Sept., swept concern for the health of the fledgling bird over the amateur satellite community. Alerted to the anomaly, spacecraft controllers in Europe and the U.S. were studying the problem at presstime. Although few facts have come to light at this juncture, authoritative sources suggest the problem is not a serious one; it does not bode ill for the longevity of AO-10. This much is

Roy Neal, K6DUE (right) tells W3GEY how he,d like to approach the interview.

known so far.

At 2128 UTC Friday, 30 Sept., AO-10 passed orbit phase (mean anomaly) 40. Normally the Mode B transponder would be keyed on by the software system at this point. The MA count of 40 occurs precisely 109.30 minutes after perigee. On Friday, however, the transponder did not appear as expected. W0RPK, AMSAT's AVP/OPS notified other AMSAT managers of the anomaly and the search was on for the cause.

On Saturday, DJ4ZC was likewise surprised by the unplanned shutdown. Karl communicated with the other AO-10 controllers via the telemetry system using the so-called M-Block.

M FROM DJ4ZC, 1.10.83: DURING THIS WEEK A SWITCHOVER OCCURRED TO BCR-2 AND THE TRANSPONDER SOFTWARE-FUSE TRIPPED YESTERDAY. AFTER RESETTING ALL IS OK. THE BCR MAY HAVE BEEN TRIGGERED BY STARTING ECLIPSES; PHIL, HW? THE TRANSPONDER FUSE COULD HAVE BEEN TRIGGERED BY T-PA OR U-BAT 11 V; I INCREASED THE T TRIP-POINT FROM 40 TO 44C. TOMORROW TORQUING TO A NEW ATTITUDE WILL START AFTER TODAYS RECAL. OF ALL THE NAV PARAMETERS. MODEL L IS PLANNED FOR WED AND SAT APOGEES ± 1 HOUR. 73 KARL

Thus DJ4ZC suggests that the Mode B may have been shutdown by a watchdog thermal sensor built into the Integrated Housekeeping Unit (IHU) to prevent damage from high temperatures. Karl's reference to eclipses and "Phil, HW?" refer to predictions of the eclipse season previously disseminated by Phil, KA9Q. Phil's table of eclipses for AO-10 showed a series of eclipses beginning mid-September. The parameter "T-PA" in the M-Block refers to the Power Amplifier Temperature of the Mode B amplifier. Karl indicated he has increased the shutdown temperature to 44 C (111 F). The "BCR" is the Battery Charge Regulator.

Meanwhile JR1SWB reported that normal Mode B operations resumed at about 1215 UTC Saturday, 1 October. Later that day the problem apparently recurred since Mode B failed to appear as scheduled at about 2047 UTC when it again passed MA 40.

The M-Block above also confirms discussions held earlier in the week concerning full-period Mode B and new Mode L operating times. Full-period Mode B should begin on Monday, QRP day, on 3 October. The full-period operation is entered as an experiment, according to W3GEY, since the performance during the perigee period is expected to be poor. The poor performance will be attributable to the antenna angle, the fact that the 2-meter omni may be bent and the high degree of spin-QSB resulting. Nevertheless, Mode B should be on for all the time that Mode L is off. As also disclosed above, Mode L will now be heard on Saturday apogees as well bringing the total of Mode L operations to an average of 8 hours per week. (2 hours per apogee on Wednesdays and Saturdays with 2 apogees per day, approximately.) The ratio of B/L would then be about 21:1. That ratio is expected to reflect Mode B and Mode L traffic levels with Mode L's enormous 800 kHz bandpass serving as a safety valve against heavy Mode B traffic. With the improvements in the Mode L sensitivity noted in a related story in this issue, many new stations are expected to populate the new turf on 1269 MHz.

The Mode-B shutdown had AMSAT and *Amateur Satellite Report* office phones the focus of dozens of concerned callers. All wanted to know if the trouble were serious and how "their bird was fairing."

W8DX, the satellite veteran-of-veterans called from Detroit in obvious distraught condition seeking assurances that AO-10 was alive and well. W4BIW opined that he hoped AO-10 weathered the present situation well "because I don't feel like setting up EME antennas in the yard" apparently alluding to EME being the only remaining challenge and he'd much rather have fun with man-made satellites than the natural kind (the moon)!

Late information suggests the shutdown was due to the conjunction of eclipse with seasonal high temperatures. Voltage trip-point reduced from 13.0 to 12.0 Vdc. No damage to the spacecraft has occurred.

DL Report Cites Failure Mechanism

After an extensive study of the circumstances surrounding the failure of the AMSAT OSCAR 10 kick motor, AMSAT DL has released the following report. The report is quoted verbatim except for minor editorial changes for publication here.

I. General

As a consequence of the collision of the third stage of Ariane L6 with OSCAR 10, the orbit injection sequence had to be changed. This report presents what has been accomplished and what problems were encountered.

II. Planned Nominal Sequence

The spacecraft was designed to be separated from the launcher with a spin rate of 10 RPM and an orientation such that a small motor-driven maneuver could be performed on orbit 3. Following this maneuver, about four weeks were scheduled for reorientation and calibration of the OSCAR 10 attitude control system. When the correct attitude for a second spacecraft maneuver was attained, the spacecraft was to be injected into an orbit with 57 degree inclination and 1,500 km perigee.

III. Actual Sequence of Events

After the collision with the launcher shortly after separation, OSCAR 10 was spinning at minus 2 RPM. The sun angle was approximately 70 degrees. This attitude resulted in the spacecraft temperatures being very much below specifications. Moreover, the power production was extremely low. The low spin rate in conjunction with the aerodynamic drag at perigee resulted in a daily improvement of sun-angle of about 3 to 4 degrees. It was thus decided to not adjust the attitude until the sun-angle had improved sufficiently to bring power production and temperatures again into specifications and until the sensors allowed unambiguous atttiude determination.

These conditions were met one week after launch. At that time an emergency spin-up maneuver was initiated to allow the normal attitude control system to take over. The spin rate and attitude were adjusted to the first firing attitude until July 8. The first motor firing maneuver duration was increased because of the delay in first firing date and the consequential changes in sun-angle. The new post-first-firing values were to be 19 degrees inclination and 1,500 km perigee.

Local weather conditions at the primary control site prevented satisfactory telemetry reception on July 8 so the firing was moved to July 11. The first motor firing maneuver occured at 22:29 UTC. The motor performed flawlessly. However, it was later learned that the burn duration was 185 seconds rather than the planned 105.

The cause of the longer than planned burn was investigated and traced to a drawing error in the AMSAT-built Liquid Ignition Unit (LIU). The increased burn duration resulted in an orbital inclination of 25.9 degrees and a perigee height of 3,950 km. A secondary result of the extended burn was that the Helium bottle temperature dropped to minus 10 degrees C; again outside of its specifications.

One day later it was noticed that the low pressure Helium indication had dropped to one half of its nominal value while the high pressure reading remained about 200 Bars. Proceeding under the assumption the low pressure Helium gauge was at fault, we reoriented the spacecraft to the new firing attitude. On July 19 at 00:29 UTC the second firing was attempted. However, even though the magnet activation was confirmed, no firing occurred and there were no changes in the indicated pressures.

Consequently, the spacecraft reorientation was initiated such that operations could commence August 6 at 18:00 UTC using the existing orbit.

IV. Investigation into the Loss of Helium

Telemetry data from various control stations worldwide was collected until August 1 in order to reconstruct the pressure history of the spacecraft. From the data collected, it can be unambiguously inferred that the Helium loss occurred on the high pressure side of the gas system and that the time constant was 500 minutes. Furthermore, when the pressure fell below 7 Bars, the time constant changed to about 10 days. This finding rules out any leak in the motor or in the fluid tank system. An investigation with Messerschmitt-Boelkow-Blohm (MBB) on August 2 left only two candidate causes for the leak:

a) the seal of the Helium bottle

b) an "AN3" connection from the Helium pyrotechnic valve leading to a check point

Model calculations and the observed behavior of the Helium seal in earlier tests led to discarding the "AN3" theory as the cause of the leak. It is now concluded with a high degree of certainty that the Helium bottle seal caused the gas loss.

We believe the following conditions led to this gas loss:

1) The Helium bottle used in OSCAR 10 was developed by AMSAT DL with assistance from DEVLR [abbreviation unknown-Ed.] because the more conventional gas containers did not fit into the available physical space. The composite technology employed resulted in a bottle which could be specified for service only for temperatures above 0 degree C. Differential temperature expansion problems precluded hermeticity guarantees below 0 degrees C.

2) As a consequence of the poor sun angle subsequent to deployment, OSCAR 10 experienced a total of 14 cold cycles beyond its specifications early in its life. Some temperature excursions were to as low as minus 10 degrees C.

3) Shortly before the launch campaign, an error in the thermal design was discovered. The error would have resulted in operating temperatures 10 degrees lower than the design target for OSCAR 10. Using the limited resources available at Kourou the design could be modified only to the extent that 5 degrees of the 10 degree error could be recovered. As a result, the spacecraft temperature is 5 degrees lower than originally planned.

4) The extended burn led to another low temperature cycle of the Helium bottle to minus 10 degrees C.

Each of these conditions would not, taken separately, have resulted in a leak. However, the cumulative effect of the initial cold cycles probably reduced the tension of the helium bottle seal to about one half of its design value. The temperature drop during the first burn plus the pressure change likely reduced the seal tension sufficiently to have caused the leak.

The following evidence supports this finding:

1) The Helium high pressure indicator exhibits a shift of the zero-line by about 200 Bars. This pressure gauge is a strain gauge affixed to the bottle. The observed shift evidences irreversible bottle dome material deformation.

2) The change in the leak time-constant at 7 bars can be explained by the fact that the bottle seal contains a Teflon O-ring which, from prior experience, is known to seal between 5 to 10 Bars. (No such ring exists in the AN3 connection).

V. Conclusion for Future Phase III Spacecraft

a) The thermal design of the spacecraft will be changed to increase the temperature to a nominal design.

b) AMSAT will make every effort to replace the solid propellant motor planned for Phase IIIC by the MBB liquid propulsion system. A solid propellant motor would not have survived the thermal abuse of OSCAR 10. The liquid propulsion system provided margins that were instrumental in saving the mission.

c) For Phase IIIC, AMSAT will attempt to redesign the Helium bottle such that its operating temperature can be specified to minus 10 degrees C.

VI. Conclusion Regarding Operations of OSCAR 10

The present orbit of OSCAR 10 provides about 40 percent of the radio coverage compared to the originally planned 57 degree inclination orbit.

Furthermore, the low inclination forces antenna off-pointing and/or operational quiet times for about 40 percent of the time because of sun-angle constraints. Consequently, operational capability of OSCAR 10 is reduced to about one fourth of its planned value. Also, because of the 17 day periodicity of the satellite's footprint, unfortunate week-long interruptions in East-West traffic (e.g., over the North Atlantic) results.

On the positive side it may be noted that OSCAR 10 can meet all its scientific objectives and that the communications capability is so large that even one fourth of its nominal capability represents a very significant communication potential for amateur radio operators. This is all the more true since this is the first working spacecraft of this series and the users can take only previous OSCARs as basis for comparison. Plainly, OSCAR 10 presents a dramatic improvement.

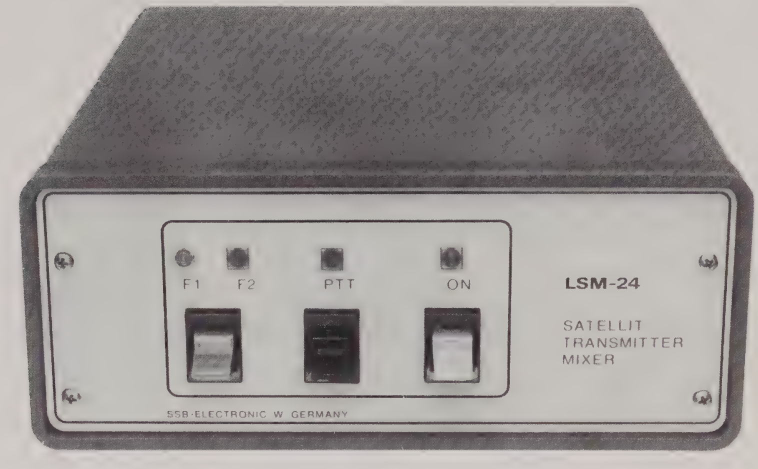
Mode L Down (But Not Out!)

Initial in-orbit tests of AO-10 Mode L (24 cm up, 70 cm down) on 21 Sept. were disappointing according to several who participated. Opening day for Mode L found scores of anxious UHFers perched on their seats ready to pounce. Although both the General and Engineering Beacons came on and were monitored at their anticipated, strong levels, signals from the Mode L transponder were extremely weak or entirely absent. Initial estimates placed the levels at least 20 dB below anticipated. Those stations heard were found to have prodigious

The Lab.

VHF – UHF – SHF – PRODUCTS

Phase III - Equipment



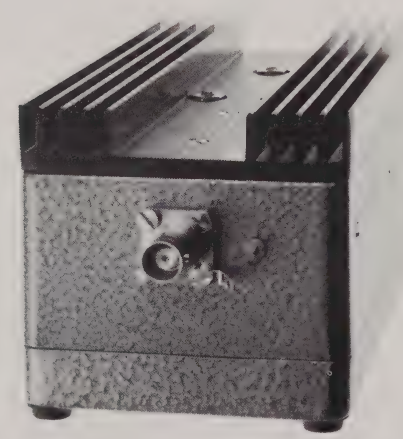
LSM 24
23-cm TRANSMITTER MIXER

INPUT FREQUENCY	: 144 - 146	MHz	LINEAR OUTPUT POWER	: 0.5	W
INPUT POWER	: 0.1 - 10	W	SUPPLY VOLTAGE	: 13.8	V
OUTPUT FREQUENCY	: 1268 - 1270	MHz	PRICE $	: ON REQUEST	

NEW!

DISTRIBUTOR FOR THE UNITED STATES

THE VHF SHOP
GERRY RODSKI
BOX 349 RD 4
(717) 868-6565
Mountaintop, Pa. 18707



PA 2310
LINEAR POWER AMPLIFIER

FREQUENCY RANGE	: 1250 - 1300	MHz
DRIVE POWER	: 0.5	W
OUTPUT POWER	: 10	W
SUPPLY VOLTAGE	: 13.8	V
PRICE $	: ON REQUEST	

Send 6 IRC's for fully detailed cataloque „COMPONENTEN & SYSTEME“ giving you complete informations about PREAMPS, CONVERTERS, TRANSVERTERS and rare components. (In German language)

SSB ELECTRONIC

Postfach 199 5860 Iserlohn W.-Germany
Tel. (0 23 71) 5 04 44 Telex 827 803 ssb d

AMSAT OSCAR-10 Frequency Conversion Chart

(Revised 9/8/83)

Revised Mode B Frequency Guide*

(Exclusive of Doppler Shift)

Uplink			Downlink
		145.987	Engineering Beacon
435.0323	Scheduled Use	145.9720	SSC H1
435.0423	Scheduled Use	145.9620	SSC H2
435.0447		145.9600	GCB Upper Limit
435.0477		145.9570	ACNF
435.050		145.955	
.055		.950	
.060		.945	
.065		.940	
.070		.935	
.075		.930	
.080		.925	
.085		.920	
.090		.915	
.095		.910	
.100		.905	
435.1037	Center Band	145.901	
.105		.900	
.110		.895	
.115		.890	
.120		.885	
.125		.880	
.130		.875	
.135		.870	
.140		.865	
.145		.860	
.150		.855	
.155		.850	
.160		.845	GCB Lower Limit
435.1647	Scheduled Use	145.8400	SSC L2
435.1747	Scheduled Use	145.8300	SSC L1
		145.810	General Beacon

*Based on conversion frequency of 581.0047 MHz.
SSC — Special Service Channel
GCB — General Communications Band
ACNF — AMSAT Calling and Net Frequency

Preliminary Mode L Frequency Guide*

(Exclusive of Doppler Shift)

Uplink			Downlink
1269.050		436.950	Upper Limit
.075		.925	
.100		.900	
.125		.875	
.150		.850	
.175		.825	
.200		.800	
.225		.775	
.250		.750	
.275		.725	
.300		.700	
.325		.675	
.350		.650	
.375		.625	
.400		.600	
.425		.575	
1269.450	Center Band	436.550	
.475		.525	
.500		.500	
.525		.475	
.550		.450	
.575		.425	
.600		.400	
.625		.375	
.650		.350	
.675		.325	
.700		.300	
.725		.275	
.750		.250	
.775		.225	
.800		.200	
.825		.175	
1269.850		435.150	Lower Limit
		436.040	Engineering Beacon
		436.020	General Beacon

*Based on a translation frequency of 1706.00 MHz, estimated.

amounts of rf at their disposal.

Apparently it required all that could be mustered from an amateur staion to produce a usable signal on the 70 cm downlink. Several stations were producing in excess of 40 dBW EIRP (10,000 watts effective isotropic radiated power). That was a far cry from the 30 dBW (1000 watts) EIRP expected to produce usable downlinks. What had happened?

AMSAT technical managers in Germany and the U.S. quickly ascertained that the Mode L transmitter appeared normal. The nominal signal strength of the beacons was clearly an index to a good transmitter. Attention focused on two areas primarily: the Mode L receiver and the Mode L antennas. Each was suspected as the potential culprit because of prior difficulties.

The Mode L receiver was a possible malfunction locus. It had failed during a thermal vacuum test at the Goddard Space Flight Center the first week in June, 1982 (See *Amateur Satellite Report* #35, June 14, 1982). Could a similar failure have occurred?

The Mode L antennas were the next suspect. After the collision with the Ariane launcher 52 and 55 seconds subsequent to deployment it was learned that the 2 meter high gain array had been deformed. Could the 24 cm helix have been zapped as well?

Several observable facts argued strongly against the "Broken/Bent Antenna" theory. The signals that were transponded, although weak, were very steady in amplitude; no discernable QSB above a dB. It would be hard to imagine a broken or bent helix showing that degree of circularity opined VP Engineering W3GEY.

That left the L-receiver and a few other possibilities to be looked at. One of the other possibilities concerned the function of an antenna switching relay in the Mode L receive circuit. It was designed to select between the 24 cm helix and the 24 cm turnstile. The relay, a sophisticated transfer relay of aerospace quality made by Transco, was evaluated since among possible failure points it had the best chance of being the culprit. That's because, reliability engineers point out, the MTBF (Mean Time Between Failures) of a relay might be an order of magnitude less than a solid state circuit (such as the Mode L receiver) when the latter is operated at low (electrical) stress levels. For example, it's obvious that a 1 watt resistor dissipating 5 microwatts should last a lot longer than a similar one running 900 milliwatts! The same holds for transistors. The Mode L receiver is designed with low stress levels to increase the MTBF to the order of years. But relays are a different story. Though simple in principle, they often play havoc with reliability requirements.

Because the relay seemed to be the most logical failure point, DJ4ZC and colleagues

Satellites & 73

When it comes to covering satellite communications, *73* runs rings around the competition. *73* publishes more articles about satellites and TVRO than any other ham radio magazine.

- more OSCAR articles
- more LISTENING articles
- more TVRO articles

In fact, since January of 1982, satellite-related articles have averaged 25% of the total number of articles published per issue of *73*. The most recent of those covered such topics as:

- OSCAR Tracking Antennas
- PHASE III
- OSCAR By The Numbers

And our regular monthly feature "SATELLITES" contains the latest AMSAT news, news of the Soviet satellites, OSCAR orbits, and more.

Learn more about satellite communications—subscribe to *73* Magazine and receive 12 monthly issues for only $19.97. Simply complete the coupon below (a photocopy is acceptable) and mail it to:

73 Magazine
P.O. Box 931
Farmingdale NY 11737

☐ ***YES!*** ***I want 12 issues of 73 for only $19.97.***

☐ ***Check Enclosed*** ☐ ***Bill Me*** ☐ ***VISA*** ☐ ***MC*** ☐ ***AMEX***

Card# ______________________ Exp. date ____________

Signature______________________ Interbank # ____________

Name ______________________

Address______________________

City______________________ State__________ Zip __________

Canada and Mexico—$22.97 1 year US funds only
Foreign surface—$39.97 1 year US funds drawn on US bank only
Foreign Airmail—Please Inquire
Allow 6–8 weeks for delivery.

73 Magazine ● *PO Box 931* ● *Farmingdale NY* ● *11737* 728RBT decided that it might help to cycle the relay through a few engagement-disengagement sequences. It if were stuck, it was reasoned, the sequencing might "un-stuck" it.

On the next Mode L schedule beginning one hour before the 15:09 UTC apogee on 28 Sept., the relay activation and cycling was performed. Apparently it had a therapeutic effect for thereafter the signal levels were up considerably. In fact, DJ4ZC stated after the tests that now the signal levels had improved such that they were down by only 10 dB. He concluded that there was in fact some problem with the antenna relay.

While there was no reason for optimism earlier in the week and it appeared only the very powerful, EME-class stations would be able to use Mode L, now there WAS room for hope. Use of Mode L was approaching the region of "ordinary" well-equipped UHFers, that is something less than 40 dBW. Now the optimism is based on doing more of the same. If a few cycles of the relay did some good, more cycling should do more good, the logic seems to indicate. Right? Maybe!

In examining relay failure modes several possibilities have been discussed. These tend to cluster about the various nasty things that happen in objects in space: heat, cold, vacuum, radiation and in our case, unanticipated physical jolts. Or had the relay been defective before launch?

As is apparent, there remain more questions that firm answers. What is known *does* give reason for hope that this latest episode in the unfolding drama will have a happy ending.

Whether the malady is the result of relay insulation outgassing (RTV, polyethylene, PVC or the like) film deposition on the contacts or some other more mechanically-based malfunction, the tale shall be told in the next week or two. By then new relay-exercise software will attempt to clear the malfunction by further application of the prior therapy. The Amateur world again holds its breath while the technical managers match wits with AO-10, Nature and "Murphy" to get to the bottom of yet another Phase III side-trip-surprise. But then, one needs reflect that this REALLY IS new territory we're in and we shouldn't be too surprised...when we're surprised!

Product File . . .from page 21

8) Expandability to 21, 24.5, and 28 MHz in the near future.

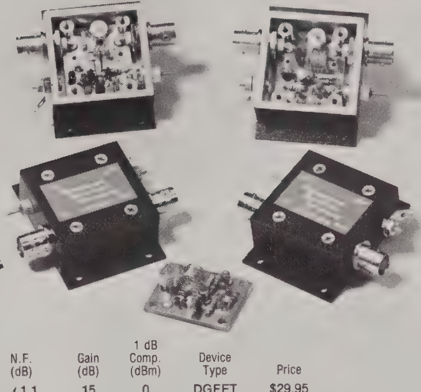
9) 16 button Touch-Tone mike supplied (real nice when your a control operator for an autopatch repeater).

In my estimation this radio is one of the finest pieces of equipment that has come out of any amateur equipment manufacturer in years. I especially want to compliment the people at Yaesu for having the foresight and daring to produce this rig prior to the launch of OSCAR-10. They got a major jump on the remainder of the market which I feel will pay off for them. Yaesu has donated an FT-726R that is being presented by AMSAT as a first place prize in our July-December membership drive. Your time and effort in recruiting new members for AMSAT may well be rewarded in winning the most advanced "state-of-the-art" transceiver designed for satellite work.

High Performance

vhf/uhf preamps

EME
Scatter
Tropo
Satellite
ATV
Repeater
FM Equipment
Radio Telescope



NEW GaAsFETs!

	Freq. Range (MHz)	N.F. (dB)	Gain (dB)	1 dB Comp. (dBm)	Device Type	Price
P28VD	28-30	‹1.1	15	0	DGFET	$29.95
P50VD	50-54	‹1.3	15	0	DGFET	$29.95
P50VDG	50-54	‹0.5	24	+ 12	GaAsFET	$79.95
P144VD	144-148	‹1.5	15	0	DGFET	$29.95
P144VDA	144-148	‹1.0	15	0	DGFET	$37.95
P144VDG	144-148	‹0.5	24	+ 12	GaAsFET	$79.95
P220VD	220-225	‹1.8	15	0	DGFET	$29.95
P220VDA	220-225	‹1.2	15	0	DGFET	$37.95
P220VDG	220-225	‹0.5	20	+ 12	GaAsFET	$79.95
P432VD	420-450	‹1.8	15	– 20	Bipolar	$32.95
P432VDA	420-450	‹1.1	17	– 20	Bipolar	$49.95
P432VDG	420-450	‹0.5	16	+ 12	GaAsFET	$79.95

Advanced Receiver Research

Preamps are available without case and connectors: subtract $10. Other preamps available in the 1 - 800 MHz range. Prices shown are postpaid for U.S. and Canada. CT residents add 7-½% sales tax. C.O.D. orders add $2. Air mail to foreign countries add 10%.

Box 1242 • Burlington CT 06013 • 203 582-9409

MasterCard VISA

Inline Relays and Other Ham Accessories

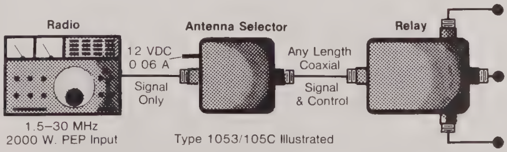
Switch All Your Antennas Over One Coaxial Feedline

With INLINE weatherproof coaxial relays you can add 2, 3, 6, or even 9 antennas without costly control cables. INLINE Relays take the guesswork out of point to point HF communications. By selection, you can instantly compare one antenna to another, switch monobanders, switch from horizontal to vertical, add WARC band antennas, create simple directable wire or vertical arrays, or whatever else you can dream up. On VHF-UHF you can significantly reduce hardline usage, eliminate tower-caused directivity, change polarization, change frequency, or switch antennas.

INLINE relays can be installed virtually anywhere without expensive and unsightly multiwire control cables. They can be placed in the attic, on the roof, on a mast, on a tree, on a tower, anywhere the antennas are.

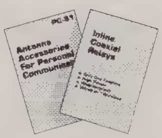
Some of Our Distinguished Customers

- TRW
- IBM Corp.
- Microlog Corp.
- ITT Mackay
- Eastman Kodak Company



Call or Write for Your Free Literature Today

Contact us and we'll send literature on our relays. And, if you like, we can include our complete catalog of ham antenna accessories.



PC-81
Antenna Accessories For Personal Communications
Inline Coaxial Relays

UNADILLA/REYCO/INLINE
A Division of Microwave Filter Co., Inc.
6743 Kinne Street
East Syracuse, NY 13057
Toll Free 1-800-448-1666 TWX 710-541-0493
NY/HI/AK/Canada (collect) 315-437-3953

EEB

Your Satellite Headquarters

Electronic Equipment Bank

516 Mill Street N.E. Vienna, VA 22180

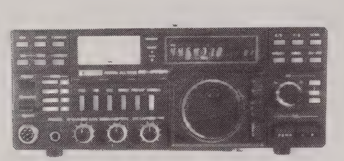
Order Toll Free 800-368-3270

Yaesu

Yaesu FT-726R V/UHF All Mode Tribander

- ★ Three Bands
- ★ 70 cm GaAsFET preamp
- ★ SSB, CW, FM
- ★ 20 Hz/Tuning steps
- ★ Speech Processor
- ★ Eleven memories
- ★ Band scan
- ★ VFO data exchange
- ★ Satellite Operation
- ★ Dual meters
- ★ built-in power supply
- ★ AGC, Noise Blanker, Squelch
- ★ Memory backup
- ★ I-F Shift
- ★ CW Filter option
- ★ VOX/CW Semi break-in

ICOM



ICOM VHF/UHF Transceivers

IC-271A:
- ★ 25 watts output
- ★ 32 Memories
- ★ Subaudible tones
- ★ PLL to 10 Hz
- ★ High visibility display
- ★ Scanning
- ★ Dual VFOs

IC-471:
- ★ 32 Memories
- ★ Subaudible tones
- ★ PLL to 10 Hz
- ★ Scanning
- ★ 430-450 MHz
- ★ 1 MHz up/down
- ★ Offset for memory

Antennas	**Rotors**	**Amplifiers**	**Power Supplies**
CUSHCRAFT	KENPRO	LUNAR	ASTRON
HY-GAIN	CDE (Telex)	MIRAGE	
KLM	ALLIANCE	TOKYO HY-PO	**LNA Converters**
TET			LUNAR

EEB

EEB is your one-stop place to shop for OSCAR-10

Please call us for pricing information:

800-368-3270 Va. 703-938-3350

Tues. Wed. Fri. 10 A.M. - 5 P.M.
Thurs. 10 A.M. - 9 P.M. Sat. 10 A.M. - 4 P.M.
Closed Sunday and Monday

We accept VISA/MC Sorry no COD

Plan to visit us the next time you're in Washington

EEB

Comets

DALLAS HAM-COM '83 One of the best ever!

In what must be scored as one of the highlights of the convention season, AMSAT's team of Texans and "would-be" Texans teamed to make this year's Ham-Com one of the best ever. Held June 3, 4, and 5 in fabled Dallas, more than a thousand dollars in donations was added to the AMSAT coffers.

Under the able leadership of AMSAT Assistant Vice President Doug Loughmiller, KO5I, the team comprising WB5PMR, N5AHD, WD0ETZ, KG5U, WB9FLW and Special Guest Speaker WB1EYI "wowed" the crowd with news of AMSAT-OSCAR 10 and Hams-In-Space ala Astronaut Owen Garriott, W5LFL. The Sunday morning activities included a fantastic three hour forum featuring Al Brinkerhoff, WB5PMR, Doug, KO5I, Steve Place, WB1EYI, Bob Diersing, N5AHD and Bill Read, WD0ETZ.

A special hospitality suite got things rolling early on Friday evening. The suite was open-

DESIGN EVOLUTION IN RF P.A.'s

Now with GaAs FET Preamp

- Linear (all mode) RF power amp with automatic T/R switching (adjustable delay)
- Receive preamp option, featuring GaAs FETS (lowest noise figure, better IMD). Device NF typically .5 dB.
- Thermal shutdown protection incorporated
- Remote control available
- Rugged components and construction provide for superior product quality and performance
- Affordably priced offering the best performance per dollar
- Designed to ICAS ratings, meets FCC part 97 regulations
- 1 year transistors warranty
- Add $5 for shipping and handling (Cont. U.S.). Calif. residents add applicable sales tax.
- Specifications/price subject to change

MODEL 1	FREQUENCY 2	OUTPUT POWER	INPUT POWER	SUGG. PRICE LESS TAX
	(MHz)	(W)	(W)	$
1410 1410G	144	160	10	225 265
1412 1412G	144	160	30	199 239
2210 2210G	220	130	10	225 265
2212 2212G	220	130	30	199 239
4410 4410G	440	100	10	225 265
4412 4412G	440	100	30	199 239

1. Models with G suffix have GaAs FET preamps. Non-G suffix units have no preamp.
2. Covers full amateur band. Specify 10 MHz Bandwidth for 420-450 MHz Amplifier.

★*SEND FOR FURTHER INFORMATION*★

TE SYSTEMS

TE SYSTEMS
P.O. Box 25845
Los Angeles, CA 90025
(213) 478-0591

N5BRG (left) and WB5PMR at the Booth.

Steve Place, WB1EYI, AMSAT-OSCAR forum speaker at Ham-Com '83.

ed to all in attendance at the convention. Hundreds took advantage.

The booth was extremely busy all Saturday with lots of enthusiasm evident throughout the crowd as many pressed in close to learn about the latest news from the world of amateur space. The mood was very upbeat according to observers present.

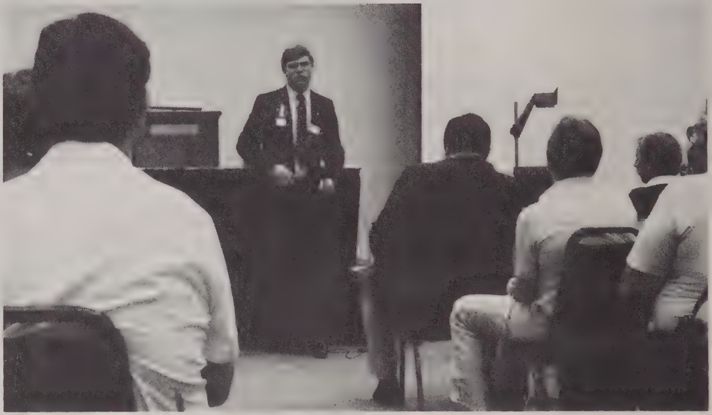
Al spoke on how to get started in amateur satellites. Doug followed with a look at some AO-10 operating considerations. Steve told how the Special Service Channels were intended to be used and also addressed the upcoming flight of Columbia on STS-9. Assisting Steve in this discussion was the President of the Johnson Space Flight Center Amateur Radio Club, Dale Martin, KG5U.

Bob Diersing gave some insight to packet radio communications and was followed by Bill Reed describing how packet radio will soon be carried aloft aboard a PACSAT satellite. Bill was ably assisted in his PACSAT talk by Pete Eaton, WB9FLW.

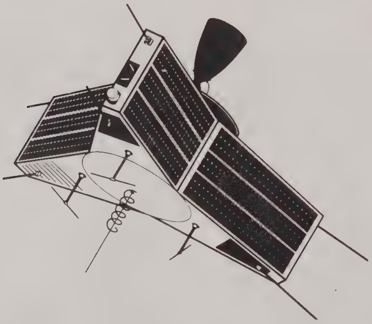
Besides the excitement generated by this team of experts, they managed to bring in dozens of new members. The AMS-81 software package was a popular item according to KO5I. Belt buckles and other AMSAT premiums were snapped up by the enthusiastic Dallas crowd!

All in all a first rate job and one worthy of emulation throughout the AMSAT fraternity. *ORBIT* congratulates the "First Team" from Texas! Well done, guys!!!

WB5PMR speaking at the forum.



KO5I at the Dallas Ham-Com '83.



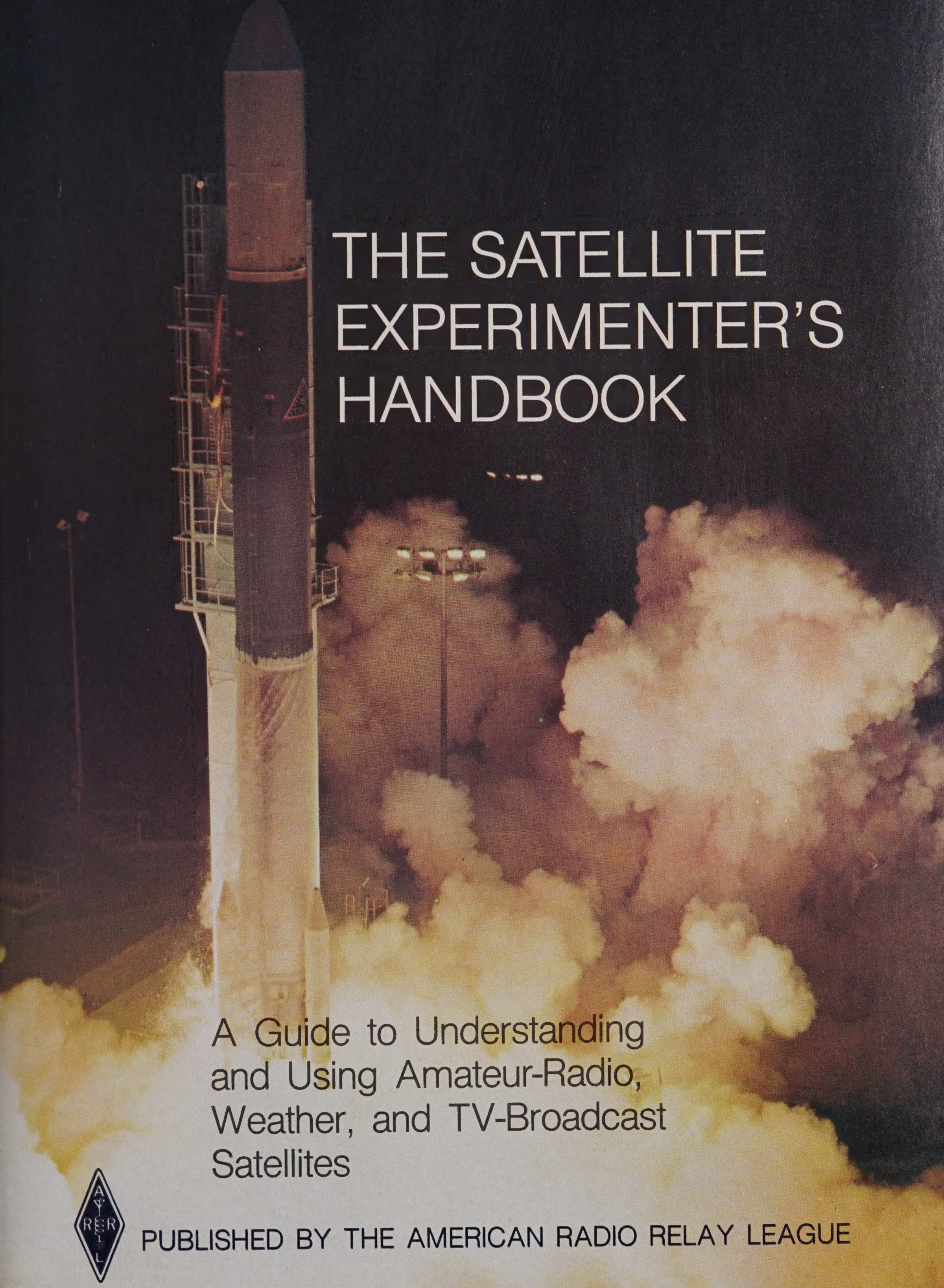
THE SATELLITE EXPERIMENTER'S HANDBOOK

Now, under one cover, here is all you need to communicate through or pick up the signals from orbiting satellites. Whether your interest is in Amateur Radio, weather or TV-broadcast spacecraft, you'll find what you're looking for in *The Satellite Experimenter's Handbook.*

Since the first OSCAR (Orbiting Satellite Carrying Amateur Radio) was launched in 1961, thousands of ham radio operators, scientists, educators and satellite enthusiasts from around the world have used these "birds" for pleasure, education and experimentation. You can join them! And if you're already into satellite communications, you'll find a wealth of practical information on all aspects of these spacecraft—from satellite design to ground-station equipment and antennas.

Whether you're a beginner, an experienced satellite enthusiast, a teacher or a scientist, you'll find *The Satellite Experimenter's Handbook* to be indispensable. $10 U.S., $11 in Canada and elsewhere.

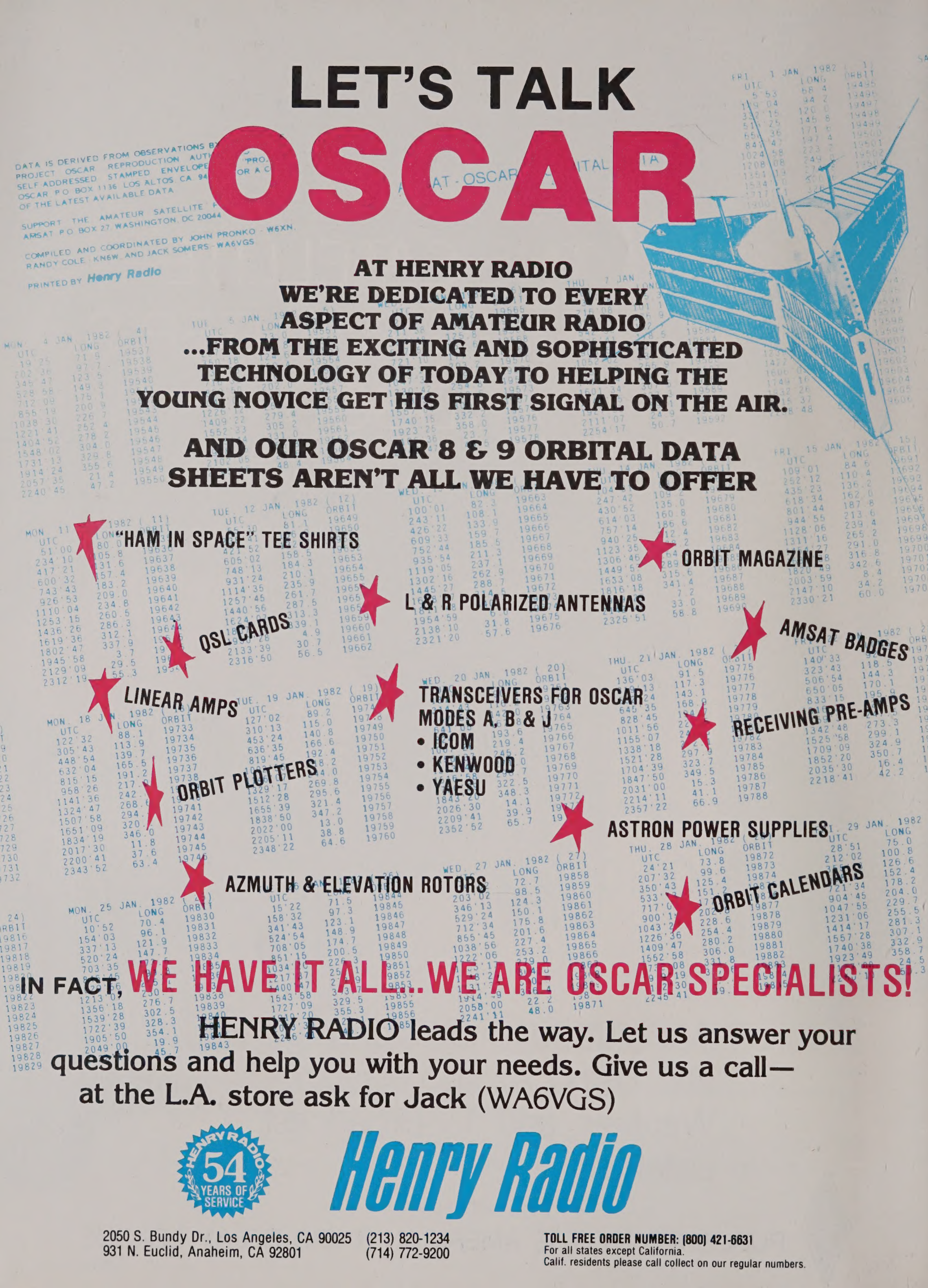
Copies available soon.



THE SATELLITE EXPERIMENTER'S HANDBOOK

A Guide to Understanding
and Using Amateur-Radio,
Weather, and TV-Broadcast
Satellites

PUBLISHED BY THE AMERICAN RADIO RELAY LEAGUE



LET'S TALK OSCAR

DATA IS DERIVED FROM OBSERVATIONS BY PROJECT OSCAR REPRODUCTION AUTH SELF ADDRESSED STAMPED ENVELOPE OSCAR P.O. BOX 1136 LOS ALTOS CA 94 OF THE LATEST AVAILABLE DATA
SUPPORT THE AMATEUR SATELLITE ARSAT P.O. BOX 27 WASHINGTON DC 20044
COMPILED AND COORDINATED BY JOHN PRONKO · W6XN RANDY COLE · KN6W AND JACK SOMERS · WA6VGS
PRINTED BY Henry Radio

AT HENRY RADIO WE'RE DEDICATED TO EVERY ASPECT OF AMATEUR RADIO ...FROM THE EXCITING AND SOPHISTICATED TECHNOLOGY OF TODAY TO HELPING THE YOUNG NOVICE GET HIS FIRST SIGNAL ON THE AIR.

AND OUR OSCAR 8 & 9 ORBITAL DATA SHEETS AREN'T ALL WE HAVE TO OFFER

"HAM IN SPACE" TEE SHIRTS

ORBIT MAGAZINE

L & R POLARIZED ANTENNAS

QSL CARDS

AMSAT BADGES

LINEAR AMPS

TRANSCEIVERS FOR OSCAR MODES A, B & J
- ICOM
- KENWOOD
- YAESU

RECEIVING PRE-AMPS

ORBIT PLOTTERS

ASTRON POWER SUPPLIES

AZMUTH & ELEVATION ROTORS

ORBIT CALENDARS

IN FACT, **WE HAVE IT ALL...WE ARE OSCAR SPECIALISTS!**

HENRY RADIO leads the way. Let us answer your questions and help you with your needs. Give us a call— at the L.A. store ask for Jack (WA6VGS)

HENRY RADIO 54 YEARS OF SERVICE

Henry Radio

2050 S. Bundy Dr., Los Angeles, CA 90025 (213) 820-1234
931 N. Euclid, Anaheim, CA 92801 (714) 772-9200

TOLL FREE ORDER NUMBER: (800) 421-6631
For all states except California.
Calif. residents please call collect on our regular numbers.

YAESU FT-726R TRIBANDER

NEW GALAXIES OF PERFORMANCE ON VHF AND UHF

FULL DUPLEX!!

SATELLITES!!

SCATTER!!

FM!!

EME!!

The New Yaesu FT-726R Tribander is the world's first multiband, multimode Amateur transceiver capable of full duplex operation. Whether you're interested in OSCAR, moonbounce, or terrestrial repeaters, you owe yourself a look at this one-of-a-kind technological wonder!

Multiband Capability

Factory equipped for 2 meter operation, the FT-726R is a three-band unit capable of operation on 10 meters, 6 meters, and/or two segments of the 70 cm band (430-440 or 440-450 MHz), using optional modules. The appropriate repeater shift is automatically programmed for each module. Other bands pending.

Advanced Microprocessor Control

Powered by an 8-bit Central Processing Unit, the ten-channel memory of the FT-726R stores both frequency and mode, with pushbutton transfer capability to either of two VFO registers. The synthesized VFO tunes in 20 Hz steps on SSB/CW, with selectable steps on FM. Scanning of the band or memories is provided.

Full Duplex Option

The optional SU-726 module provides a second, parallel IF strip, thereby allowing full duplex crossband satellite work. Either the transmit or receive frequency may be varied during transmission, for quick zero-beat on another station or for tracking Doppler shift.

High Performance Features

Borrowing heavily from Yaesu's HF transceiver experience, the FT-726R comes equipped with a speech processor, variable receiver bandwidth, IF shift, all-mode squelch, receiver audio tone control, and an IF noise blanker. When the optional XF-455MC CW filter is installed, CW Wide/Narrow selection is provided. Convenient rear panel connections allow quick interface to your station audio, linear amplifier, and control lines.

Leading the way into the space age of Ham communications, Yaesu's FT-726R is the first VHF/UHF base station built around modern-day requirements. If you're tired of piecing together converters, transmitter strips, and relays, ask your Authorized Yaesu Dealer for a demonstration of the exciting new FT-726R, the rig that will expand your DX horizons!

Price And Specifications Subject To
Change Without Notice Or Obligation

YAESU
The radio.

483

YAESU ELECTRONICS CORPORATION 6851 Walthall Way, Paramount, CA 90723 • (213) 633-4007
YAESU CINCINNATI SERVICE CENTER 9070 Gold Park Drive, Hamilton, OH 45011 • (513) 874-3100

TR-9130

All mode (FM/SSB/CW) 25 watts, plus...!!!

The TR-9130 is a powerful, yet compact, 25 watt FM/USB/LSB/CW transceiver. Available with a 16-key autopatch UP/DOWN microphone (MC-46), or a basic UP/DOWN microphone.

TR-9130 FEATURES:

- 25 Watts RF output on all modes, (FM/SSB/CW).
- FM/USB/LSB/CW all mode. Selectable tuning steps of 100-Hz, 1-kHz, 5-kHz, 10-kHz.
- Six memories. On FM, memories 1-5 for simplex or ±600 kHz offset, using OFFSET switch, Memory 6 for non-standard offset. All six memories may be simplex, any mode.
- Memory scan.
- Internal battery memory back-up, using 9 V Ni-Cd battery, (not KENWOOD supplied). Memories are retained approx. 24 hours, adequate for the typical move from base to mobile. External back-up terminal on the rear.
- Automatic band scan.
- Dual digital VFO's.
- Transmit frequency tuning for OSCAR operations.
- Squelch circuit for FM/SSB/CW.
- Repeater reverse switch.
- Tone switch.
- CW semi break-in; sidetone.
- Compact size and lightweight.
- Covers 143.9 to 148.9999 MHz.
- High performance noise blanker.
- HI/LOW power switch. 25 or 5 watts on FM or CW.
- RF gain control. • RIT circuit.

Optional accessories:

- KPS-7A AC power supply.
- PS-20 AC power supply (TR-9500 only).
- BO-9A system base with memory back-up supply.
- SP-120 external speaker.
- TK-1 AC adapter for memory back-up.

TR-9500

70 CM SSB/CW/FM transceiver

- Covers 430-440 MHz, in steps of 100-Hz, 1-kHz, 5-kHz, 25-kHz or 1-MHz.
- CW-FM Hi—10 W, Low—1 W. SSB 10 W.
- Automatic band/memory scan. Search of selected 10-kHz segments on SSB/CW.
- 6 memory channels.

TS-780

All mode "Dual-Bander" ...2-m & 70-cm all mode, dual digital VFO's, 10 memories, scan, IF shift...

TS-780 FEATURES:

- USB, LSB, CW, FM all mode, covering the 2-m band (144.000-148.000 MHz) and the middle 70-cm band (430.000-440.000 MHz). UP/DOWN band switch.
- Dual digital VFO's with normal/tight drag switch. VFO steps in 20-Hz, 200-Hz, 5-kHz, or 12.5-kHz, plus "FM CH" channelized tuning. Split (cross) frequency operation possible. F. LOCK switch provided.
- 10 memories include band and frequency data, backed up by internal batteries (not supplied). Battery life exceeds one year. Memories 9 and 10 for priority instant recall.
- Band scan, with selectable 0.5, 1, 3, 5, and 10-MHz scan bandwidth.
- Memory scan selectable for all memories, or 2-m or 70-cm only.
- IF shift circuit rejects adjacent interference.
- High sensitivity and wide dynamic range.
- 7-digit fluorescent tube digital display.
- 10 watt RF output.
- 2-m ±600-kHz TX offset switch with reverse switch.
- Tone switch for optional TU-4C programmable two-frequency CTCSS encoder unit.
- VOX and semi break-in CW built-in.
- FM center-tune meter.
- Noise blanker for SSB, CW.

TS-780 accessories:

- **TU-4C** programmable two-frequency CTCSS encoder.
- **MC-42S** 500 Ω UP/DOWN hand microphone.
- **MC-48** 16-button Autopatch UP/DOWN microphone.
- **MC-60A** deluxe desk top microphone.
- **MC-80** desk top UP/DOWN microphone.
- **TK-1** AC adaptor for memory back-up.

Subject to FCC approval

NEW

KENWOOD

TRIO-KENWOOD COMMUNICATIONS
1111 West Walnut, Compton, California 90220